JOURNAL
OF
ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

VOL. 13 APRIL, 1920 No. 2

Proceedings of the Thirty-Second Annual Meeting of the American Association of Economic Entomologists

(*Continued from p. 147*)

Afternoon Session, Thursday, January 1, 1920, 12.45 p. m.

PRESIDENT W. C. O'KANE: The first paper on the program is "Features of the Codling Moth Problem in the Ozarks," by Dwight Isely and A. J. Ackerman.

SOME FEATURES OF THE CODLING MOTH PROBLEM IN THE OZARKS[1]

By DWIGHT ISELY and A. J. ACKERMAN, *Bureau of Entomology*

A number of features of the codling moth problem in the Ozarks vary quite widely from its usual aspect in most of the apple regions of the United States. The relatively southern latitude of the Ozark region with its long growing season gives time for a larger number of broods than in regions farther north. Its inland situation and distance from bodies of water which produce equalizing effect upon temperature is probably responsible for the comparatively erratic seasonal history. The large number of broods and the fact that two of these broods, moths of the first and second, and immature stages of the second and third, occur during the heat of summer (a condition favorable to extraordinary prolificacy) produces an infestation of greater severity

[1] This paper is based on studies of the life history and control of the codling moth conducted during the seasons 1918 and 1919 at Bentonville, Ark., under the direction of Dr. A. L. Quaintance. The Bureau of Plant Industry represented by Mr. Leslie Pierce coöperated in spraying experiments. Mr. F. L. Wellman assisted the writers in routine work during both seasons.

Presented with permission of secretary of agriculture.

than is the rule in most fruit regions. These features of the codling moth problem, abundance, the variations in seasonal history, and the remedial measures necessary, are the subject matter of this paper. Particular attention is given to conditions differing from those reported by Jenne for 1907 and 1908. It is probable that similar conditions to those mentioned below are found in the fruit regions of southern Illinois, and of the Arkansas Valley in Kansas, whose geographical position in a general way resembles that of the Ozarks.

Abundance

The extent of loss to the apple crop in the Ozarks due to codling moth injury is very frequently underestimated by entomologists not familiar with this region. This is due in part to the fact that the codling moth apparently was not a particularly serious problem when experimental work was previously carried on here by the Bureau of Entomology in 1907 and 1908. In 1907 on the unsprayed check trees in the experimental orchard Jenne found only 34 per cent of the apples infested with "worms," and a very satisfactory control was secured on the sprayed plats. However, when the writers first came to the Ozarks they found the situation very different. There were many growers who said that they despaired of ever seeing the codling moth controlled and that they expected that at least 50 per cent of their apples would be infested by "worms" annually in spite of five or six spray applications.

The general report was that the codling moth problem had gradually become serious, but had been acute only the last few years. One was left to assume that this changed status of the pest was due to the more intensive development of the apple industry in this region or to the gradually cumulative effect of inefficient remedial measures.

Whatever the cause, the codling moth problem was found to be very serious. In 1918, in the check plat of an experimental orchard, 72.67 per cent of the apples were infested. This percentage does not indicate the full severity of the infestation, for in making counts all dropped fruits were included. Much of this fruit, which had been attacked by scab or had not been pollenated, fell early in the season before it had opportunity to be attacked by codling moth. The fruit which fell late in the season and that which was harvested was practically 100 per cent infested. In addition, more than one worm per apple was the rule rather than the exception with the apples that remained on the trees late in the season. One apple was noted that had been attacked by as many as eleven worms. In addition to the unsprayed check there were a large number of orchards dusted in 1918 and nearly all of these and a few that had been sprayed five and

ix times showed as high or nearly as high an infestation as the check. To be sure, in these sprayed orchards the work had not been as thorough s was possible but in some it had been thorough enough to have controlled apple scab in a bad scab year.

The infestation for the season of 1919 was less severe. Fruit from he check plats in the experimental orchards was only 47.55 per cent nfested, and the "extra worms" per apple were much less numerous. There were practically no dusted orchards in the region this season.

In 1917 no experimental work was conducted in the Ozarks. However, one of the writers was present during apple harvest and he found he codling moth not generally as injurious as it became the following eason, but in some orchards the infestation ranged from 50 to 70 per cent.

The above data on abundance of codling moth during three seasons pplies to the majority of orchards in this region. However, there are ccasional orchards in which codling moth injury is comparatively ight and in which the apparent immunity is not due to the effective pplication of remedial measures, but must be charged to natural onditions. These orchards are usually isolated and often quite disant from the main fruit growing sections. In some instances these ow infestations are directly attributable to the loss of a crop the previous season because of frost injury or poor care. Conversely the most heavily infested orchards are regular bearers and in the heart of the ruit section.

Seasonal History

The seasonal summary which will be given herewith is based on nsectary records which were checked up by band records and field bservations. The rearing methods employed in the insectary were or the most part the same as those usually followed in the Bureau of Entomology and have been previously described. Battery jars were sed for moth emergence, oviposition, and rearing of larval and pupal tages. Larvæ were allowed to spin cocoons in the standard "pupaticks," and jelly tumblers were used for incubation. Our methods iffered from the usual as follows: Records of moth emergence and upation of material in battery jars were checked up by records of naterial reared in wire cloth cylinders, which were kept both in the nsectary and suspended around a tree trunk in the insectary yard. Oviposition from which incubation records were to be made was secured on pieces of dry twigs about two inches long. These seemed to s to have the advantage over leaves in that the latter when drying njured a percentage of the eggs. Paper was substituted for cheese loth in making covers for the battery jars, when it was desired to prevent evaporation.

All larvæ upon which records of the overwintering brood were based were collected in the fall. The number of individuals used to determine the duration or time of occurrence of any stage was made to correspond, as far as possible, with the degree of variation to be expected and the economic importance of the phenomena in question. As for instance the period of spring emergence of moths is of first importance and is exceedingly variable, and for this it was aimed to procure over 3,000 overwintering larvæ. On the other hand the duration of the incubation period in midsummer is relatively constant and of little economic importance and records of 20 to 30 eggs per day were all that were attempted. To check up insectary records larvæ were collected under bands at intervals of three days in two orchards in 1918 and in three orchards in 1919.

During the first season of the writers' residence in this region, that of 1918, there were three full broods and a partial fourth brood of codling moth larvæ. Previous records have shown three broods for this region. As far as the writers are aware four broods are recorded from only one other state, New Mexico. The season of 1918 was very favorable to codling moth development, the summer as a whole and month of August in particular being remarkable for high temperatures. During the heat of summer all stages were passed rapidly.

The record of emergence, for this season, of the overwintering brood of codling moth extended from April 29 to June 3, and records of hatching of first brood larvæ from May 17 to June 13. The earliest first brood moths were secured June 15 and the first second brood larva, June 25. From this date until the early part of October the second and following broods continued hatching daily. Moths of the second and third broods began emerging July 27 and September 12 respectively, and their offspring, the larvæ of the third and fourth broods, began hatching August 4 and September 23 respectively. The second and third, and third and fourth broods overlapped to such an extent that it was impossible to separate them even in a general way either by field observations or band records. Most larvæ spinning cocoons after September 1 entered hibernation. Harvest of Jonathan apples was nearly over at this time and harvest of Ben Davis started by September 15. As a result many undeveloped larvæ of the third and nearly all of the fourth brood were carried out of the orchard with the fruit.

The feature of the seasonal history of the codling moth in 1919 was the length of the period between the beginning of emergence of overwintering moths and the beginning of hatching of larvæ in economic numbers. The earliest record of moth emergence was April 20 and by the middle of May nearly half of the brood had emerged. The first

record of hatching of larvæ was May 13 but until May 28 hatching both in the insectary and in the field appeared to be negligible. The general accuracy of these records was confirmed later by collections of larvæ from bands.

This long period of 38 days between the emergence of the first moth and hatching of larvæ in economic numbers was, no doubt, due to relatively warm weather during the early part of April which advanced the emergence of moths, followed by a succession of cold waves during the first three weeks of May which retarded or altogether prevented oviposition until about half the overwintering brood of moths had died. During the last week of May with the return of warm weather reproduction progressed rapidly. As a result practically all of the first brood larvæ were progeny of this second half of the overwintering brood of moths. The total period of emergence of overwintering moths was nearly two months, from April 20 to June 18, while the bulk of the resulting larvæ were hatched within three weeks beginning May 28.

The development of the two following broods was entirely regular except that the early part of the second brood was very light and practically negligible as might be expected following the peculiar development of the first brood. Both second and third broods were about a week later in appearing than they had been the year before. No records of a fourth brood were secured. The earliest record of a first brood moth was June 24 and of a second brood moth August 2. Larvæ of the second and third broods began hatching July 2 and August 12 respectively. As during the previous season both of these broods were present during the season of highest temperatures. While the second and third broods overlapped so that the hatching of larvæ was continuous from July until about October 1, the close of the season, the slackening of activity between broods was quite evident from band records. Larvæ began hibernation about the last of August or nearly the same time as the previous season but apple harvest was between two and three weeks later. Most of the worms had left the fruit and spun their cocoons before late apple harvest.

For the seasons of 1907 and 1908 Jenne reared three broods. In 1908 the emergence of moths was recorded as early as April 1, and larvæ as early as April 27. Their development during this season, however, was relatively slow.

The time of hatching of larvæ in economic numbers in relation to the falling of the petals varied considerably. In 1918 the interval was three weeks, while in 1919 it was five weeks. Jenne's records for 1907 and 1908 are six weeks and three weeks respectively.

From the standpoint of control there are but two distinct periods of codling moth hatching during which the fruit must be protected not-

withstanding the fact that three or four broods may occur annually. The first period is covered by the first brood and the second period by the second and following broods, which overlap so heavily that they are to all intents one brood. In this respect the problem in the Ozarks resembles that of northern fruit sections since the two dates of particular importance in the seasonal history of the insect are: the time of beginning of hatching of first brood larvæ in economic numbers, and the time of beginning of hatching of the second brood larvæ. The problem differs materially in that instead of one or two second brood applications, three or four applications are necessary for the second and following broods.

All spray applications, with the exception of the calyx spray, are based upon these two dates. As may be expected a spray application is made at the beginning of the first brood and of the second brood. An additional first brood spray is applied at a fixed interval (usually two weeks) following the first application to give continuous protection. Additional applications for the second and following broods are spaced at intervals following the first second brood application to give protection until near harvest. This interval is usually three weeks and is based on the growth of the fruit and amount of precipitation. The time of beginning of hatching of the third and fourth broods is not of consequence in planning a spray schedule as there is no interval between broods when it is safe to leave the fruit unprotected.

It is more difficult to determine the time for making the earliest first brood application than the first second brood application.

As noted above there are anywhere from three to six weeks after the falling of the petals before larvæ of the first brood begin hatching in appreciable numbers. With such a variation it is not possible to recommend for any season in advance that the first spray following the calyx application should be made at a stated time, say three or four weeks later as seems to be practical in many other regions. The time for this application must be determined by life history studies each season. To make the matter more difficult the time of emergence of the earliest moths is not a reliable index for the time of the beginning of hatching of larvæ in economic numbers, as the interval between these events of seasonal history varies to too great an extent. The interval was 18 days in 1918 and 38 days in 1919.

The time between the emergence of the earliest first brood moths and the hatching of the earliest second brood larvæ was 10 days in 1908 and 1918 and 8 days in 1919. Hatching in considerable numbers began soon after. It is reasonable that the timing of the first second brood spray may safely be based on the beginning of emergence of first brood moths.

Remedial Measures

Experimental spraying for the control of the codling moth was carried on for the seasons of 1918 and 1919, the time of applications being based on the life history studies. A few of the plats covering the work for each season are given in Table I, which shows the percentage of fruit free from codling moth for each plat. All plats shown in this table, except the checks, received six sprays with arsenate of lead beginning with the calyx application followed by two others for the first brood and three others for the second and following broods. Plats 1 during both years were the demonstration plats on which spray rods, with nozzles having very fine openings in the discs, were used throughout the season after the calyx application, which gave a complete covering of the fruit until near the close of the season. Plats 14 and 13 were the unsprayed plats for 1918 and 1919 respectively. In 1918 on plat 9 and in 1919 on plat 7 a spray-gun was used from the ground, and in 1919 a spray-gun was used from the tower on plat 6.

Table I. Comparison of Sprayed and Unsprayed Plats for 1918 and 1919, Bentonville, Ark.

Plat	Total fruit	Total wormy	Per cent free from worms
1918			
1	5,241	757	85.55
9	4,184	1,950	53.39
14 (Check)	3,380	2,456	27.33
1919			
1	8,934	64	99.28
6	6,573	1,455	77.86
7	11,944	1,513	87.33
13 (Check)	12,568	5,975	52.45

A comparison of the check plats for each season shows that the codling moth infestation was much more serious during 1918. The last spray application during that season was made on August 5 and apparently it was effective until the last week in August by which date very few worms had infested the fruit. The hot weather referred to above which continued until late in the season produced, however, an unprecedented crop of late worms many of which were able to enter the fruit. An additional spray, applied two to three weeks after August 5, doubtless would have protected the fruit against this late infestation of worms. Fully two-thirds of the wormy apples on plat 1 can be attributed to these late worms. The percentage of wormy fruit on all plats that received less than six applications during 1918 was considerably higher than on plat 1.

By following practically the same methods in 1919 the same number of applications produced almost perfect results, 99,28 per cent of the fruit being free from worms in comparison with 85.55 per cent for the

previous season. Cooler weather prevailed throughout 1919, however, so that no part of a fourth brood appeared; all broods were later in the season, and the infestation was correspondingly less as is shown by the check plat. The last spray, put on August 11 to 12, was late enough to protect the fruit against all late worms. On one plat a later application was made but this proved to be unnecessary.

In the case of plat 9 in 1918 where a spray-gun was used from the ground nearly one-half of the fruit was wormy. In 1919 on plats 6 and 7 where the spray-gun was used from the tower and the ground the results were 77.86 and 87.33 per cent respectively. This may be explained by the fact that it is impossible to give the fruit as fine a coat of spray material with the gun and the tendency to overspray some parts of the trees and underspray other parts is greatly increased. The results in these plats were relatively much poorer in 1918 when the infestation was much more severe than in 1919. It is probable that these results may not be applicable in regions where the infestation is less severe and where the requirements of spray being distributed uniformly over the apple is less exacting. However, these plats clearly demonstrate the inefficiency of relatively coarse sprays under Ozark conditions.

The conclusions that may be drawn from the experimental work in the control of the codling moth in the Ozarks thus far are the necessity of making six to seven spray applications, depending upon the season, and the desirability of a very fine mist in preference to a coarse spray.

MR. E. G. KELLY: What pressure did you use with the gun?

MR. DWIGHT ISELY: Two hundred and fifty pounds.

PRESIDENT W. C. O'KANE: The next paper is "Some Experiences with the Codling Moth," by T. J. Headlee.

SOME EXPERIENCES WITH THE CODLING MOTH

By THOMAS J. HEADLEE, PH.D., *New Brunswick, N. J.*

NEW JERSEY CONDITIONS

It no doubt seems to many of the members of our association, particularly the younger ones, that the codling moth is an exceedingly threadbare subject, but the writer's experience in the last two years with this insect has indicated to him that there are still many important facts in connection with its control that are not yet sufficiently understood. In the last two years, he has seen pretty nearly nine out of every ten orchardmen in his state fail to obtain a satisfactory control of this insect. Not only has he observed it in New Jersey, but he finds that a similar condition appears to exist in the state of Delaware.

This is not because these growers have not had the benefit of information gathered about this insect in the country at large, but because spraying methods as outlined by these studies have in most cases proven insufficient to handle the codling moth when it occurs in maximum numbers in that part of the Atlantic Coastal Plain above referred to.

The writer has not been able to find any thorough-going studies of this insect in this region of the country and there is reason to suspect that its habits differ materially from those exhibited in parts of the United States where careful studies have been made. Furthermore the rainfall in this portion of the Atlantic Coastal Plain is large, especially abundant during the first half of the apple growing season and consequently spraying materials stick less well to the foliage and fruit of apple.

It is true that a good many individual orchardists in New Jersey have been able to prevent the codling moth from doing their crops serious harm, but in all cases with which the writer is familiar where these results have been obtained, the coating of spray materials has been maintained year after year from the dropping of the petals through the first half of the growing season.

With these facts in mind an investigation of the codling moth with special reference to the entrance of the fruit by the larvæ was undertaken at the beginning of last summer. Two orchards were selected, one at Maple Shade in Burlington County about 5 miles northeast of the city of Camden and the other at Glassboro in Gloucester County about 20 miles southeast of Camden. Each orchard was located in a large orcharding section. It was anticipated that the difference in location was sufficient to produce a slight difference in the life cycle of the insect, but the study showed distinctly that the seasonal cycle in each place was practically identical. The work at these two places was checked with observations made at New Brunswick. There appears to exist between the life cycle of the codling moth at New Brunswick on the one hand and Maple Shade and Glassboro on the other hand, a difference of about one week. At Maple Shade and Glassboro the adult moths began emerging about May 3, reached their maximum about June 1 and ceased about June 12. The second brood began emerging about July 8, reached maximum about July 29 and ceased September 1. The first brood larvæ began entering the apples about June 1, reached maximum about June 25 and ceased about July 8. The second brood larvæ began entrance about July 25, reached maximum about August 11 and ceased about September 15. The apple bloom in general covered a period of nearly two weeks, the blossoms falling off the trees about May 3. From the falling of the petals until the begin-

ning of entrance by the first brood larvæ there was a period of about four weeks. From the falling of the bloom to the beginning of entrance by the second brood larvæ there was a period of nearly twelve weeks. In cases where the time of spraying was determined by the entrance of the larvæ such a degree of control was obtained that less than one per cent of the picked fruit showed injury by the codling moth. This occurred even in orchards where the previous year had shown in spite of spraying over 50 per cent of the picked fruit damaged by this insect. In one orchard of over 100 acres of pears where the previous year not less than 60 per cent of the fruit was damaged by the codling moth, this year less than one per cent of the picked fruit showed injury. This year it made the owner a good profit. About 40,000 baskets of pears were harvested and sold, none of which brought less than ninety cents a basket.

Control Problems

There seem to be two main problems in meeting the codling moth as the writer has seen it in New Jersey. The first is concerned with the comparative value of the three sprays that are usually recommended for its control. The second is concerned with finding the relation between the time when the spray should be applied and the development of the trees.

Nearly but not quite all of the most careful work hitherto done, so far as the writer has had a chance to examine it, seems to indicate the preëminent importance of the blossom fall spray. Large amounts of data covering periods of several years have been gathered by Quaintance[1] and his associates, Ball,[2] Melander[3] and Felt.[4] These collections of data all seem to indicate unmistakably that the first or blossom fall spray is many times more important than any other spray for control of the codling moth. Sanderson[5] presented a keen analysis of the results obtained up to that time and showed that up to 1909 the data gave the place of first importance to the blossom fall spray but that the later sprays were also of large importance. Furthermore, most of the workers, who maintain the preëminent importance of the blossom fall spray recommend later sprays as well. The writer has seen orchards in each of the last two years where the amount of blossom end worminess would not amount to one-tenth of one per cent and he has seen some instances in which it was almost impossible to find any whatever,

[1] Quaintance *et al.*, Bur. of Ent., U. S. Dept. of Agric., Buls. 80, Pt. VII, 1909, 1915, Pt. II, 1912 and 88, 1914.

[2] Ball, E. D., Utah Station, Bul. 95, 1904 and 129, 1911.

[3] Melander, A. L., Wash. Sta. Bul. 103, 1911, and others issued personally.

[4] Felt, E. P., Jour. of Econ. Ent., Vol. 5, page 153, 1912.

[5] Sanderson, E. D., Jour. of Econ. Ent., Vol. II, pages 141–153, 1909.

although the same orchards at the end of the season showed from 50 to 85 per cent of the picked fruit wormy. During the past season he observed rather closely some apple trees near his home which received no growing season spray whatever. The blossom end worminess in these trees was an almost negligible factor, but at the end of the season not much less than 100 per cent of the picked fruit was ruined by the codling moth. There is no intention to regard these observations as being in any way sufficient to controvert the great mass of evidence in the other direction, but it is thought they indicate that codling moth habits as determined in the country at large may not apply completely to codling moth habits in the Atlantic Coastal Plain. There is no doubt whatever in the writer's mind that a single spray applied by orchardmen at the blossom fall under codling moth conditions, such as obtained in New Jersey, during the past two years will utterly fail to give satisfactory control. He believes this to be true even where the spray is applied with the utmost care and thoroughness.

It thus appears that the observations recorded above indicate first, that blossom fall spray does not possess in all cases the preëminent value it has been shown to have where studies hitherto have been made and, second, that the sprays given at the entrance of the first brood larvæ and at the entrance of the second brood larvæ are also of prime importance in effecting satisfactory control.

Examination of spraying schedules published by different station and government agencies in this country indicate that there exists a difference of opinion as to the method which should be chosen to outline the proper time of spraying. Some schedules designate the sprays as coming so many days and weeks after the blossom fall, others indicate the proper time of spraying by means of a day and monthly date and still others use a combination of the two methods. The labors of Melander,[1] Jenne,[2] Hammer[3] and Siegler-Simanton[4] indicate that the period separating the falling of the blossoms and the emergence of the adult moths is a rather highly variable thing. The work of Hammer also indicates that the time of the activity of the second brood varies but little from year to year. This condition would appear to indicate for sprays intended to protect the fruit from the side worms of the first brood larvæ, there is no very definite method of determining the proper time and that a day and month date indication should be sufficient for the spray intended to protect the fruit from the side worm of the second

[1] Melander, A. L., Wash. Sta. Bul. 77, 1906.

[2] Jenne, E. L., Bureau of Ent., Bul. 80, Pt. I, 1909, interval 6 and 3 weeks.

[3] Hammer, A. G., Bureau of Ent., U. S. Dept. of Agric., Bul. 115, Pt. I, 1912.

[4] Siegler, E. H., Simanton, F. L., Bureau of Ent., U. S. Dept. of Agric., Bul. No. 252.

Chart 1

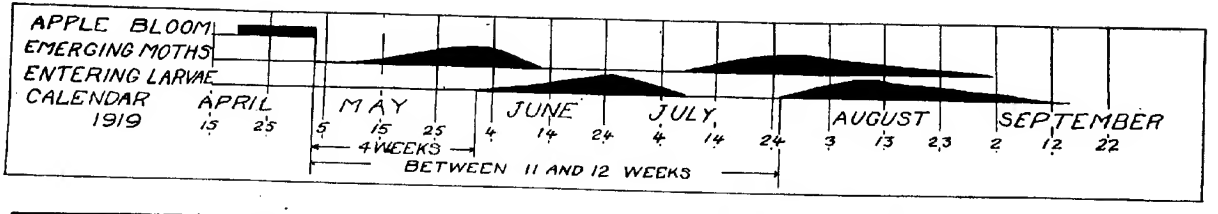
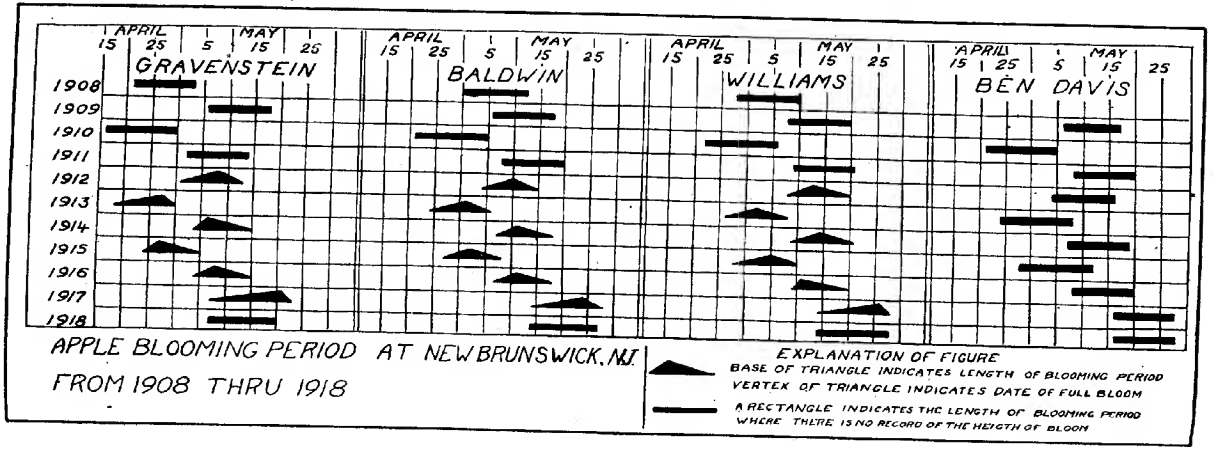


Chart 2



brood. All studies agree in placing the time for the first spraying for codling moth at the falling of the blossoms. Taking the great mass of codling moth study in general and accepting the work of the men mentioned, the writer believes that the consensus of opinion would place the spraying which is intended to protect the fruit from the side-worms of the first brood about three weeks after the blossoms fall and would place the spray which is intended to protect the fruit from the side worms of the second brood about nine weeks after the blossoms fall.

A study made of the blooming period for Gravenstein, Baldwin, Williams and Ben Davis, extending from the year 1908 to the year 1918 shows an extreme variation of about three weeks and an average variation of a trifle over a week. It is the writer's understanding, drawn from different sources, that this variation is due primarily to temperature. Knowing the tremendous retarding effect of low temperatures and the large accelerating effect of higher temperatures, the writer is inclined to believe that the temperature factor would operate upon the codling moth in much the same way and to about the same extent as it does on the tree. He is, therefore, inclined to think that the interval existing between the blossom fall and the larval entrance into the fruit is not so variable as has hitherto been shown. Without doubt factors of moisture seem to influence the codling moth pupa somewhat differently from the way in which they influence the blooming period of the tree and variations due to that cause may very well take place, but the amount of variations resultant is not likely to be large enough materially to change the relationship between the time of bloom and the time of larval entrance.

The facts above set forth seem to leave the question of the method of indicating the time of the spray for control of the first brood of side worms unsettled. It may be said that Quaintance has obtained excellent results from the day and month date method and that equally good results have been obtained by following a schedule based on the blossom period. The underlying factors do not seem to have been worked out and further investigations will, in the writer's opinion, bring them forth.

EXPLANATION OF CHARTS 1 AND 2

Chart 1 showing the emergence of broods of moths and the period covered by the entrance of their larvæ into the apples in 1919, at Maple Shade near Camden, N. J.

Chart 2 showing the blooming period of four varieties of apples from 1908 to 1918 inclusive. Extreme variation is about three weeks and average about one and one half weeks.

The writer wishes to invite attention to the fact that in his judgment enough study has been given to various insects, especially apple aphis to indicate that insect habits on the coastal plain are somewhat different from the habits of the same species in other parts of the United States. The past year's preliminary study of the codling moth in this area seems to bear out this general conclusion. This is not at all surprising because of climatic differences, especially as regards humidity and temperature. If this is so, it follows that any country-wide study of an injurious species should include the Atlantic Coastal Plain as one of the regional areas, the conditions of which must be determined.

Examination of the results of work on codling moth has served to deepen a conviction that has been growing upon the writer for some years:—that in the past and at present the study of insects economically important over several regional areas has been carried out with altogether too little coöperation between state and between state and government agencies. This has resulted in sets of data which are very largely not comparable. If the other method had been taken it is reasonable to anticipate that the essential points in the codling moth control problem would now have been in hand.

Conclusions

In conclusion it should be said that:

First, as shown by a single year's investigation there are only two broods of codling moth in New Jersey;

Second, the blossom fall spray does not appear in this study to have the preëminent importance which it has been shown to have in previous studies elsewhere in the country;

Third, the sprays which come at the time the larvæ of the first and second broods are entering the apples are not only of much greater importance than has hitherto been attributed to them, but are absolutely necessary to satisfactory control when the codling moth is present in as great abundance as is now the case in New Jersey and probably Delaware;

Fourth, that portion of the Atlantic Coastal Plain comprised in the southern half of New Jersey and probably Delaware varies sufficiently so to modify the habits of economic species of insects coming within its range as to render the studies made of them elsewhere in the country only partially applicable to coastal plain conditions;

Fifth, studies of country-wide economic species should be carried out on a regional basis under a plan which comprehends extensive and thorough-going coöperation between state and between state and government agencies.

MR. JAMES TROOP: . I would like to ask if he found any well marked riod existing between the end of the first brood and the beginning the second brood of the codling moth. There are two broods. oes the first brood come to maturity in your locality before the second ood makes its appearance?

MR. T. J. HEADLEE: That is a question that I didn't work out. he chart that was passed around shows that the period of the first ood has entirely gone before the period of the second begins.

MR. JAMES TROOP: I would like to say right here that in Indiana e have been doing some work with the codling moth for several ears. Our apple growers have not been getting results by following ie programs as laid down for spraying. For the last two or three ears, we have been studying the life history of codling moth in our ction of the country. We begin with the emergence of the first oths in May. Our work consists of banding the trees, gathering the rvæ, putting them into cages, keeping these cages, as nearly as possile, under natural conditions, and making daily records of the emerence of the moths.

We have found that from the middle of May until the first of September, when our experiments stopped, we couldn't find a time when oths were not emerging. Practically every day from the time the rst moths appear, with the exception of just here and there a day, ntil they close up business in September, there is a continuous perormance right through the whole season with no break at all between he first and second broods. They are at work all the time, so we ave concluded that the only way to protect our apples is to keep the praying machine going continuously from early summer till the first f September.

PRESIDENT W. C. O'KANE: The title of the next paper is "The)yster-Shell Scale in Illinois," by P. A. Glenn.

FORMS OF THE OYSTER-SHELL SCALE IN ILLINOIS

By P. A. GLENN, *Chief Inspector, Division of Plant Industry, Department of Agriculture, Urbana, Ill.*

Doubts have been entertained by entomologists as to whether the)yster-shell scale which infests various species of deciduous trees elongs to the single European species, *Lepidosaphes ulmi*.

These doubts have been greatly strengthened in the mind of the writer by observations made during the last six years.

In Urbana and Champaign, Ill., the poplar, ash, lilac, cornus, willow and *Rosa rugosa*, are quite generally, and in most cases badly, infested by the oyster-shell scale.

In the spring of 1914 an attempt to transfer this scale from poplar,

ash and lilac to apple failed, evidently for the reason that it could not live on apple. Observations made throughout the Twin Cities disclosed the fact that apple trees though standing in such close proximity to heavily infested ash, poplar and lilac that their branches touched were free from scale; and, furthermore, pear, peach, plum, hackberry and horse-chestnut, all of which are listed as host plants of *Lepidosaphes ulmi*, standing in the same situations were likewise free. A closer examination of specimens taken from apple, poplar, ash, willow, lilac, cornus and *Rosa rugosa* brought to light two distinct forms of the scale, and a third form which differs in some particulars from that which infests apple. For the purpose of this paper we shall designate them as the brown form, the grayish-brown, or banded form, and the yellowish-brown form.

The brown form is the one which infests apple. It appears to be identical with the European species, *Lepidosaphes ulmi* Linnaeus. It has been successfully transferred to lilac, ash and cornus. An attempt to transfer it to poplar was unsuccessful, but the failure may have been due to the small number of young insects used in the experiment. The shade of color of the scale itself varies somewhat on different kinds of bark, but it is a uniform brown. In immature specimens the part of the scale developed after the first molt is darker than the exuvia. Specimens of old scale which have been exposed to the weather are very dark, nearly black. This scale is double-brooded, the first brood hatching during the first or second week in May at Urbana, the second brood during the latter part of July. This form is usually very heavily parasitized.

The grayish-brown scale is the one that is generally and destructively abundant on poplar, ash, willow, lilac, cornus, and *Rosa rugosa* in Urbana and Champaign, and at numerous other places in the northern half of the state. American elm, soft and hard maple, ailanthus and linden growing near heavily infested ash and poplar may become infested and be seriously injured by the large number of young which are carried to them annually from the infested trees, but in other situations they do not become infested, and it is doubtful whether the scale can maintain itself on them. It cannot live on apple, pear, peach, plum, hackberry and horse-chestnut.

The prevailing color of this scale is brown, but there are more or less distinct transverse grayish bands, one just behind the first exuvia, another near the middle of the scale, and a third at the posterior margin. These bands are sufficiently distinct and constant to serve as a means of distinguishing this form from the other two.

Old scales when exposed to the weather become a bluish-white. In immature specimens the part of the scale formed, after the first molt,

is nearly gray and lighter in color than the exuvia. It is single-brooded and hatches at Urbana, Ill., during the third or fourth week in May.

The yellowish-brown form has been taken on cornus, lilac, soft maple and *Rosa rugosa* at Urbana. This form resembles the brown form very closely, but the posterior half of the scale is lighter in color than the anterior part and is in most cases distinctly yellowish. This characteristic cannot always be depended upon to distinguish it from the brown form, but in connection with one of the microscopic characteristics of the two forms they can be quite readily distinguished. It is double-brooded, and is usually heavily parasitized.

Many specimens of each of these forms have been examined under the microscope and with the exception of the number of circumgenital pores they seem to be identical. Specimens were submitted to Dr. A. D. MacGillivray. He made a careful comparison of the structural characteristics which up to the present time have been used to determine the species in this genus and reported that he could find no difference.

It is interesting to note, however, that there is a striking and quite constant difference in the average number of circumgenital pores in these forms, as the following table will show:

CIRCUMGENITAL PORES

Form of scale	Number examined	Host plant	Posterior lateral groups			Anterior lateral groups			Median group			Total Average
			Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	
Brown	30	Apple	21	8	12.8	21	9	16.8	12	8	9.5	68.7
	30	"	17	8	13.9	23	12	19.	14	9	12.	77.8
	30	"	17	8	13.5	23	13	17.7	17	7	11.5	73.9
	30	"	19	8	13.8	23	13	16.8	16	6	10.5	71.7
Average	120				13.5			17.6			10.9	73.1
Yellowish-brown	36	Cornus	25	13	17.2	24	14	19.	17	8	12.	84.4
	23	"	21	12	16.1	23	11	18.6	16	9	12.	81.4
	23	Per. Lilac	22	15	16.45	23	10	19.1	21	8	13.	84.2
	24	Rosa Rugosa	24	13	16.7	24	13	18.8	18	10	13.8	85.6
Average	106				16.5			18.8			12.6	83.2
Grayish-brown or banded	27	Lilac	27	16	21.	30	15	23.2	21	11	14.4	102.8
	20	"	28	17	21.2	26	13	21.6	14	9	12.3	97.9
	32	"	27	15	19.	28	15	21.5	22	8	13.2	94.2
	30	Poplar	32	14	21.	29	17	22.7	16	10	13.9	101.3
	32	Ash	29	17	22.6	29	18	24.7	19	12	14.3	108.9
	27	Pus. Willow	27	17	21.5	28	18	23.3	11	11	14.3	103.9
	11	" "	30	22	24.3	30	17	24.5	17	10	15.1	112.7
	27	Rosa Rugosa	31	16	23.5	30	17	23.7	20	10	15.	109.4
	26	Weep. Wil.	29	16	23.2	30	21	25.	18	9	14.4	110.4
Average	232				21.9			23.2			13.9	104.1

There is a considerable variation in the number of circumgenital pores in individuals of the same group, so much so that it would be

possible to find some individuals in each of the groups which could not be properly classified by means of the circumgenital pores alone. There is also a considerable variation in the averages of lots belonging to the same form, but these variations are not so great as to render it even doubtful as to which form each of the lots belongs.

The differences which have been noted in these forms are summarized below:

Brown or apple form	Yellowish-brown form	Grayish-brown or banded form
Uniform in color	Posterior half of scale lighter in color with yellowish hue	Brown crossed with three grayish bands
Weathered scales very dark	Weathered scales very dark	Weathered scales bluish-white
Double-brooded	Double-brooded	Single-brooded
Parasitized	Parasitized	Not parasitized
Infests apple	Probably does not infest apple	Does not infest apple
Probably does not infest poplar	Infests poplar	Infests poplar
Infests pear, peach, plum, hackberry and horse-chestnut		Does not infest pear, peach, plum, hackberry and horse-chestnut
Average number of circumgenital pores, 73.1	Average number of circumgenital pores, 83.3	Average number of circumgenital pores, 104.1

We are not in a position to offer any definite suggestion as to the systematic relation of the different forms, but the one that infests the apple is no doubt identical with the European form, *Lepidosaphes ulmi*. The yellowish-brown form should probably be considered as a variety of *Lepidosaphes ulmi* Linneus. The grayish-brown or banded form may possibly be only a variety of *Lepidosaphes ulmi*, but it seems more probable that specific characteristics will yet be found which will make it possible to describe it as a separate species, or possibly to identify it as one of the other European species already described. The fact that it infests mainly artificial plantings, indicates that it has come to us in the nursery trade and probably from Europe.

At present the economic importance of the banded form is of greater concern than its systematic relations. As a fruit pest it is of no consequence, but in cities it is now much more abundant in Illinois than either of the other forms, and from the published records of the oyster-

shell scale, we may infer that this is also true in other states. It is much more destructive than the other forms and observations made during the last six years lead us to believe that it will eliminate the poplar and the ash and possibly all of its favorite host plants from parks and lawns, unless systematic control measures are adopted, or some parasite or other nautral enemy appears to keep it under control. The only evidence of such an enemy which has come to our attention was the receipt some time ago from the northern part of Illinois of some lilac which had been heavily infested by the scale, 95 per cent of which had been destroyed evidently by a bird or some predacious enemy.

This insect can be controlled by spraying with the lime sulphur wash, but the spraying of large shade trees is expensive and requires apparatus built especially for this kind of work. Spraying large street trees and trees in lawns is in many cases impracticable, because it is impossible to spray them with the lime sulphur wash without ruining the paint on nearby buildings and this wash is by far the most effective dormant spray for this insect. Miscible oils have not proven satisfactory. The only practicable method of procedure is to cut down infested trees which cannot be sprayed and replace them with others not susceptible to this pest. Poplars are especially objectionable because the scale multiplies so rapidly on them. Because of their tall growing habit they are exceedingly difficult to spray, and because of their hardiness they resist the attack of the scale and serve as disseminating centers for it for many years. For these as well as for other good reasons the poplar should be eliminated from city plantings, and other trees, not susceptible to the scale substituted. A very careful inspection should be made of nurseries and all infested stock destroyed at once. Since the control of this pest is for the most part a city problem, the attention of city authorities should be called to it, and drastic measures recommended, if necessary.

MR. CHILDS: I might say that in Hood River, Oregon, there occurs conditions relative to the habits of the oyster shell scale of much the same nature as Mr. Glenn speaks. We often find dogwood being killed by the scale in ravines running through orchards and no scales will be found on the apple trees adjoining. I have also noted this difference in the texture of the scale on different host plants.

MR. J. S. HOUSER: I was interested in what Mr. Glenn said as to the probable injury to ash by this scale. Several years ago, about fifteen, we had a very severe attack of this scale on ash in Northern Ohio. The attack was virulent for a number of years, and then it disappeared almost entirely. It required a period of something like

ten years to again become very destructive. This last destructive outbreak reached its maximum, I think, about four or five years ago, whereupon the scale again almost entirely disappeared for a year or two, but at the present time is again increasing in numbers. *Hymenopterous* parasites seem to be responsible for this irregularity in the fortunes of the insect.

At this point, the meeting of the Association adjourned and the Section on Horticultural Inspection convened.

Section on Horticultural Inspection

E. C. COTTON, *Chairman* J. G. SANDERS, *Secretary*

The Section on Horticultural Inspection met in the Soldan High School, St. Louis, Mo., January 1, 1920, at 1:30 p. m., for a single afternoon session.

In order to conserve time, the chairman, E. C. Cotton, dispensed with his address, and after preliminary remarks called for the first paper:

1. "Treating Nursery Stock for the Control of San Jose Scale," which was read by Mr. K. C. Sullivan, and briefly commented on by some of the members.

2. "The Present Status of *Aleurocanthus woglumi* Ashby in the Panama Canal Zone" was not given by Mr. H. F. Dietz, owing to his earlier withdrawal from the U. S. Bureau of Entomology, but Mr. C. L. Marlatt stated that this paper would, in all probability, be published as a bulletin of the Federal Department.

3. The paper on "Important Foreign Insect Pests Collected on Imported Nursery Stock in 1919" was read by Mr. E. R. Sasscer, and discussed by the members present.

Mr. E. E. Scholl stated that the horticultural associations of Texas strongly urged that federal port of entry inspection be established at Galveston. Report was made that federal funds for this purpose had been asked for by the Federal Horticultural Board.

4. The paper on "The Japanese Beetle Problem" was read by Mr. J. J. Davis, and a number of very interesting and instructive slides were shown. Discussion followed.

5. The paper on "The Japanese Beetle Quarantine Work" by C. H. Hadley was omitted, on account of his absence from the meeting.

6. The interesting and very instructive report by Mr. C. L. Marlatt, chairman of the Federal Horticultural Board, on "Federal Plant Quarantine Work and Coöperation with State Officials" was listened to with the greatest interest by everyone present, on account of the

importance of the coöperative possibilities of the Federal Board with state officials in the control of dangerous insects and plant diseases.

BRIEF RÉSUMÉ OF MR. MARLATT'S REPORT

It was made clear that every pronouncement and quarantine issued from the Federal Horticultural Board, is the result of careful study and consideration by leading officials of the Agricultural Department, and, finally, by the sanction of the Honorable Secretary of Agriculture. The results of investigations and the knowledge of the authorities of the entire world are brought to bear on the work of the Federal Board; state officials are taken into consultation, and full consideration is given to every proposition which comes before the board for decision.

The work of the Federal Board has grown to enormous proportions—hardly believed possible in so short a period, since the establishment of the board. The introduction of many new serious pests from foreign countries, attacking our staple crops, has demanded rapid, generous action to cope with the situation.

One of the largest problems confronting the board has been the cotton pest control in the south, particularly along the entire Mexican border, brought about by the introduction and establishment of the pink boll worm. The Federal Board at this time controls all the traffic along the entire Mexican border, and has erected the largest plants for fumigation in the world, which will accommodate fifteen standard freight cars at one time. The attempts at eradication of the pink boll worm have demanded the utmost efforts, and the keenest ingenuity and management on the part of the board officials.

The board inspection service has grown rapidly, and is now established at such important points as Boston, New York, New Orleans, San Francisco and Seattle, with other ports under immediate consideration. It would seem that ultimately the Federal Board port inspection service will be as far-reaching as the customs service, and will work jointly with the latter service.

The intensity of the work looking toward the control of several of our pests, is scarcely realized by the people generally, nor do they realize the efforts which are being made to protect the agricultural and horticultural interests of the United States at this time.

The potato wart, which has very serious potentialities, and which was introduced from Europe into several points in Pennsylvania, and has been discovered in northern West Virginia, is under strict quarantine, and hope is held that the disease may be prevented from further general spread. The determination that several of our American varieties are immune, and also the possibility that some of the immune varieties from the British Isles, which are under test, will prove satis-

factory in our climate, are indeed hopeful signs that this disease may be deprived of its dangerous possibilities.

The discovery of the European corn borer, and the subsequent enlargement of the infested area, by careful surveys, has presented another problem of importance before the board, which it is handling with all the judgment possible—in view of the slight knowledge which we have of the habits and destructive possibilities of this pest in America.

The Federal Board has made the first practical use of the aeroplane in agriculture—in scouting for the illegal growing of cotton along the Mexican border, where attempts to eradicate the pink boll worm are under way.

Quarantine No. 37.—The enactment of this quarantine has brought forth a storm of opposition from plant importers, and, unfortunately, from nurserymen and florists, who have followed the lead, and hark-ened to the frequent misrepresentations, and often wilfully erroneous statements of the plant importers. As time goes on, these nurserymen, who are growers and producers, are beginning to realize that this quarantine is for their good, and will protect their interests, as well as the agricultural and horticultural interests of the country generally, from the further importation, to a very considerable degree at least, of destructive plant pests.

It is the duty, as Mr. Marlatt said, of every state official and worker to support the Federal Board and the plant quarantine, and to over-come the unfortunate propaganda which has been spread broadcast by the plant importers and misled florists.

Finally, Mr. Marlatt impressed everyone with the importance of a full coöperation of State Quarantine Officials with the Federal Board, and assured the state officials present, that the board would coöperate with the several states in their problems in every way which seemed desirable and feasible, and, furthermore, he offered the services of the board in consideration of any plant quarantine matters which might arise.

Mr. J. G. Sanders offered a resolution, which was passed unanimously, "expressing the gratitude of the Association to Mr. C. L. Marlatt for his long and tireless efforts in securing authority from Congress to establish and to enforce plant quarantines—for the protection of agriculture and horticulture in the United States."

Mr. Paul C. Lindley, officially representing the Southern Nurserymen's Association, presented a report of action taken by the latter association, covering several matters of importance, including uniform horticultural legislation, uniform acceptance of nursery license tags,

and several other matters which are brought out in Mr. Lindley's report, which will be published. Considerable discussion was aroused by Mr. Lindley's report, and remarks were made by several, especially by F. M. O'Byrne of Florida, favoring the use of separate state numbered license tags, thus enabling state officials to keep accurate record of the nursery stock shipped into the state. Other officials felt that such detail could not be followed out, particularly in the northern and eastern states, where enormous quantities of nursery stock are shipped to very many points in the state, thus requiring the reciprocative action in other states by respecting their license tags.

The inspectors present were highly pleased to receive Mr. Lindley's report of the Southern Nurserymen's Association, and assured a kindly hearing to all representatives of the nurserymen, believing that by such exchange of ideas the best possible results can be secured in inspection work.

J. G. Sanders, Harrisburg, Pa., was elected chairman, and Mr. E. R. Sasscer, Washington, D. C., secretary for 1920, following their nominations by the nominating committee, which was composed of Wilmon Newell, Franklin Sherman and W. E. Rumsey.

IMPORTANT FOREIGN INSECT PESTS COLLECTED ON IMPORTED NURZERY STOCK IN 1919

By E. R. Sasscer, *Washington, D. C.*

Notwithstanding the fact that Belgium exported plants to the United States in the fiscal year 1919, the amount of stock entered during this period by the principal countries engaged in this type of trade, was less than in any year since 1912. The number of plants exported by each of the five principal European countries during the fiscal year 1919 is as follows:

England	1,385,548
Holland	2,403,430
France	12,948,466
Belgium	98,836
Germany	None

In fact, there was a falling off on the part of each of the countries, listed above, for the period referred to, except Belgium. This country's increase is due to the fact that no plants were exported to the United States during the fiscal year 1918. Germany, of course, has not exported plants to the United States since 1916.

An examination of the records of interceptions for the current year shows that insects arriving on imported stock have not decreased but have been equally as abundant, if not more so, than was the case in

former years. While it is true that many of these interceptions were made on plants from countries without inspection facilities, a large percentage of the interceptions were made on stock from countries which possess a recognized inspection service. As the result of some ten or more years of experience in inspection work, the writer is convinced that it is impossible for any man, or group of men, to examine a large shipment of plants and locate every insect which may be present. We have been repeatedly advised that the stock exported by the five principal countries to the United States was carefully examined by recognized experts, and yet there was seldom, if ever, a shipment of any size which did not show insects of some description when examined in this country by State or Federal Inspectors. Morever, a reinspection of these same shipments would undoubtedly reveal insects which escaped attention at the time the two previous examinations were made. It is absolutely impossible to detect insects in soil around balled plants, without removing, and, in many instances, sifting the soil, which treatment to some plants would be fatal. Fortunately, this difficulty has been eliminated by the exclusion of soil around plants. Scale insects and Aleurodids are difficult to locate even by experts on these families of insects. On a number of occasions in recent years, we have reinspected, in Washington, three or four times a half dozen of small plants infested with the mining scale (*Howardia biclavis* Comst.), and each reëxamination invariably revealed scales which were under buds or in some secluded spot, and had escaped the eyes of the inspectors on previous inspections. It is true that this scale is a difficult one to detect, but the examinations were made under favorable conditions in a well-lighted room.

Unfamiliarity with the work and injury occasioned by the oriental fruit moth (*Laspeyresia molesta* Busck) undoubtedly caused inspectors of this country to pass supposedly free but infested stock which bore a foreign certificate of inspection.

These facts are not given to minimize the work of foreign inspectors, but to emphasize that where the human element enters it is impossible to say definitely that a nursery or given shipment is free from injurious insects. Someone may say that it is possible to definitely assume that a nursery or a case of plants is free from injurious insects, but how are we to determine whether or not an insect of no economic importance in Holland will not in this country become injurious and indeed change its habits and preferred hosts.

A number of the insects referred to below, have been intercepted in former years, and if the wholesale exportation of miscellaneous plants had not been stopped these insects and many others would, no doubt, have continued to enter with foreign plants and plant products.

The pink bollworm (*Pectinophora gossypiella* Saunders) was collected in cotton seed from China, Angola, Africa, and Mexico. Inasmuch as this insect has received so much attention in literature of late, there is no need of elaborating on the injury occasioned to cotton by this pest at this time.

Yams from Jamaica were found to be infested with *Palaeopus dioscoreæ* Pierce, a weevil which, thus far, seems to be confined to that island. Sweet potatoes, arriving in New York from Antigua, British West Indies, were found to harbor living larvæ, purpæ, and adults of the scarabee (*Euscepes batatæ* Waterhouse), and sweet potato cuttings from Hawaii were infested with *Euscepes porcellus* Boheman. Apparently none of these weevils are now established in the United States.

Larvæ of presumably *Anastrepha fraterculus* Wied. were intercepted in New Orleans in grapefruit and mangos from Cuba, Guatemala, and Jamaica. The gold-tail moth (*Porthesia similis* Fuessl.) was taken on *Acer atropurpurea* and *Azalea amoena* from Holland, and the sorrel cutworm (*Acronycta rumicis* L.) was intercepted on two shipments of pear and quince from France. Nests of the brown-tail moth (*Euproctis chrysorrhœa* L.) were found in five French shipments of Cotoneaster, apple and Manetti stock, and egg masses of the gipsy moth (*Porthetria dispar* L.) were present on quince, apple, and Manetti stocks from France and on boxwood from Holland. Rhododendrons and boxwood from Holland exhibited *Agonopteryx ocellana* Fabr., and azaleas from the same country were infested with *Gracilaria zachrysa* Meyr., as were also two shipments of the same plants from Belgium.

An undescribed species of Recticulitermes was taken in moss used as packing around the roots of Litchi and citrus from the Philippine Islands, and a species of Melanotus was taken in ship's ballast from Spain. Soil around Dutch rhododendrons was found to harbor *Athous niger* L., and rice straw used as packing in Japan was infested with a species of Crambus.

Pineapple shoots from the Straits Settlements were thickly infested with a small mite (*Stigmarodes cinctus* Ewing) which seems to be established in the United States and confined to the southwest.

Japanese wistarias arrived infested with *Agromyza shineri* Girard, and a species of Xyleborus, and tamarind seed pods from Guatemala and Cape Verde Islands were infested with *Calandra linearis* Herbst. Soil around azaleas from Holland was found to carry the European mole cricket (*Gryllotalpa gryllotalpa* L.) which probably confirms the belief which has prevailed for some time that the introduction into New Jersey several years ago was attributable to soil around balled plants. Two shipments of Japanese figs were found infested with a cerambycid

(*Melanauster chinensis* Forester), and *Emphytus cinctus* L. was received on miscellaneous plants from England, Scotland, France, and Holland.

In order to get some idea in regard to the possibility of injurious insects entering in bulbs, a number of shipments were given a rather careful inspection. One Holland shipment of lily-of-the-valley was found to contain *Otiorhynchus sulcatus* Fabr., and a Pyralid (*Pyralis farinalis* L.) was collected in three shipments from France; one of hyacinths and two of narcissus. The lesser bulb fly (*Eumerus strigatus* Fallen) was taken in several shipments of Dutch and French narcissus and jonquils, as was also the narcissus fly (*Merodon equestris* Fabr.). A large percentage of the shipments were found to contain bulbs infested with *Rhyzoglyphus rhizophagus* Banks and *Rhyzoglyphus hyacinthi* Boisd.

Fully 85 per cent of the bulbs of a large shipment of French *Iris tingitana* were infested with *Anuraphis tulipæ* Boyer, and a species of the same genus was also received on *Iris alberti* from England. A new species of Liothrips was found on lily from France, and what appears to be an undescribed species of Tarsonemus was taken on narcissus from Holland. Unidentified Chironomids, Cecidomyids, and Agromyzids were also intercepted.

As in former years Coccids were frequently met with, the more important being the following:

Aspidiotus transparens Green on Cycads from Port Elizabeth, South Africa.
Selenaspidus pumilis Brain on ————, from Kimberley, South Africa.
Targionia bromeliæ (Newst.) on pineapple shoots from Straits Settlements.
Targionia hartii Ckll. on yams and sweet potatoes from Africa.
Targionia sacchari Ckll. on sugar cane from Porto Rico.
Chionaspis exalbida Ckll. on aloe and Pandanus from Port Elizabeth, South Africa.
Chionaspis niger Ckll. on Litchi from Hawaii.
Lepidosaphes alba (Ckll.) on *Manihot sp.* from St. Kitts, British West Indies, Bahama Islands, and the Belgian Congo, and on *Manihot esculenta* from Jamaica.
Parlatoria calianthina B. & L. on *Pyrus communis* from Algeria.
Parlatoria pseudaspidiotus Lindg. on orchids from the Philippine Islands.
Lecanium cerasorum (Ckll.) on wistaria from Japan.
Lecanium kunoensis (Kuwana) on plums from Japan.
Lecanium persicæ (Fab.) European Peach Scale, on *Berberis verraculosa* from France.
Pulvinaria floccifera (Westw.) on *Renanthera imschootiana* from England.
Pseudococcus boninensis Kuwana on sugar cane from Argentine.
Pseudococcus comstocki Kuw. on persimmon from Japan.
Pseudococcus crotonis (Green) on orchid from Porto Rico.
Pseudococcus sacchari (Ckll.) on cow cane from Rhodesia, also Indian cane from Rhodesia, and on sugar cane from Cuba and the Virgin Islands.
Pseudococcus virgatus (Ckll.) on Litchi from the Philippine Islands.

THE GREEN JAPANESE BEETLE PROBLEM

By JOHN J. DAVIS, *Riverton, N. J.*

It is intended at this time to give a concise résumé of the green Japanese beetle problem, including its present status, plans for future work and information which is of special interest to you whose duty it is to protect your state from the introduction of dangerous insect pests.

The green Japanese beetle (*Popillia japonica* Newm.), a native of Japan, was introduced into the United States at Burlington County, New Jersey, prior to 1916, probably five or six years ago, and presumably in the grub stage in soil about the roots of perennial plants. It was first discovered by Messrs. Harry B. Weiss and Edgar L. Dickerson about the middle of August, 1916, in a nursery, probably near the original point of introduction,[1] near Riverton, New Jersey.

The rate of increase has been remarkable. When discovered in 1916 only about a dozen beetles were found, according to Mr. Weiss, and these only after a search, while now (1919) in the same locality and at the same season one person can collect by hand 15,000 to 20,000 beetles in a day and in favorite places the grubs are as frequent as 250 to the square yard. The area of known infestation has increased from approximately 600 acres in 1917 to 15,000 acres in 1919 and according to the most conservative estimates by those familiar with the activities of the insect a year ago, the beetles were at least ten times more abundant numerically in 1919 than the previous year.

The Bureau of Entomology inaugurated a study of this insect in the late summer of 1917, Mr. Wm. O. Ellis being assigned to the study of its life history and habits. Mr. Ellis continued his connection with the project until the summer of 1919 and most of the data on the life history are the result of his investigations. In the spring of 1918 it was planned to take active steps to control and, if possible, eradicate the insect, the New Jersey State Department of Agriculture coöperating substantially. Mr. W. H. Goodwin was assigned the task of control, he and Mr. Ellis working jointly on the problem in their respective fields, the whole project being supported by an advisory board, consisting of Doctors A. L. Quaintance and Thos. J. Headlee. Mr. Goodwin continued his service in charge of control operations until the fall of 1919. The writer was assigned to this project May 1, 1919, and has had in charge of the different divisions Messrs. Goodwin for control operations, Ellis, the life history, and C. H. Hadley, the quar-

[1] It is a matter of historical interest that this insect was first found within about one-quarter mile of the place where the San José scale was first discovered in the eastern United States.

antine. At the present time Mr. Hadley has charge of the control operations and Mr. D. N. Willingmyre the clean-up work. Entomologists have not yet been assigned for the divisions of quarantine, experimental investigations or parasite introduction work for the coming season.[1]

To finance an attempt to eradicate the beetle from New Jersey, $15,000 were provided, $10,000 by the federal and $5,000 by the state governments. The project thus provided for began in 1918. It was thought at the end of 1918 that the probability of extermination was slight and that greater emphasis should be placed on control. On the basis of the accumulated knowledge and experience, it was planned to ask for an appropriation of $35,000 ($25,000 from the federal and $10,000[2] from the state governments).

This amount was granted. After a season's work and a study of the situation the past year (1919) it was decided that the policy of eradication must be abandoned for reasons which will be given later, but that a vigorous policy of control should be inaugurated. Careful estimates called for an additional minimum expenditure of $70,000 to prevent the further spread of the insect and at the same time discover practical control measures and attempt introductions of the natural enemies from Japan. Congress appropriated $45,000 of this amount and while it will enable us to do a considerable amount of needed and valuable work, it is quite insufficient to complete the plans deemed necessary for success. Regardless of the fact that the work the past two seasons has been carried out in accordance with the best knowledge of the insect's life habits, which were at that time available, the insect has enormously increased numerically and has spread at a rather rapid rate.

These details are given that you may understand the plans set forth in the following:

Life History and Habits

The life history and habits need be treated only briefly to make the problem of control understandable. The total life cycle is one year,[3] most of which time is spent in the soil as an egg, grub, or pupa. Having passed the winter in the soil, 2 to 10 or 12 inches below the surface, the half to nearly full grown grub returns to near the surface in late March

[1] I wish to take this opportunity to express my appreciation of the continuous support and help given by Doctors Headlee and Quaintance and the valuable assistance of Mr. C. H. Hadley who has always been ready to help on any phase of the work.

[2] $4,800 was made available previous to July 1, 1919, the remaining $5,200 being available for the fiscal year ending July 1, 1920.

[3] The life cycle is identical with that of certain of our *Anomalas* except that the beetles of *Popillia* are present over a much longer period.

or early April and resumes feeding. The older larvæ complete their growth by early June when they prepare earthen cells in which they transform to the pupa and about two weeks later to the adult. Previous to pupating the grub is in the prepupa or dormant stage for a period of a week or ten days, and after transforming to adult it usually remains in the cell another ten days to two weeks before coming out of the ground. Like the related leaf chafers this insect pupates within the larval skin, the skin splitting along the back almost the entire length.

The first beetle issues the last of June and the maximum period of emergence is during the latter part of July. The life of the individual beetle varies considerably, averaging from one to ten weeks, but beetles occur over a period of about four months, abundantly over a period of two to two and one-half months.

After issuing the beetles feed for several days to a week before mating. Mating and egg laying is continued at irregular intervals, the eggs being laid by preference in uncultivated places such as grassy fields or grassy and weedy areas along roadways, in moist but not swampy ground, and in soil rich in humus, each beetle laying an average of 60 eggs. The young grubs hatching from the eggs some two weeks later feed on decaying matter in the soil and to a less extent on living plant roots and late in fall they form earthen cells, in which they pass the winter.

The beetles are omnivorous, resistant to unfavorable conditions, strong fliers, and very active during warm, clear days. While they may remain above ground on plants during the night they usually feed only during the day; they are sluggish in cool or damp weather, but exceedingly active on warm, sunshiny days and fly quickly at the least disturbance, seldom going far into thickets, except on the outside foliage and never, from our observations, do they go into woodland or lay their eggs within wooded areas. They prefer grassy or weedy ground, unshaded by thickets or trees, to lay their eggs, and favor moist loamy soil in preference to dry sandy soil or swampy areas.

Importance as a Crop Pest

The insect is not injurious in the grub stage, partly because the grubs are actively feeding at a time when crops are least likely to be injured and partly because they feed as freely or more so on decaying matter as on living roots.

The beetle is a serious menace to small fruits, orchards, cereal and forage crops and to ornamentals. It is almost omnivorous, feeding, according to our records, on more than 120 plants. It feeds on weeds and wild shrubs of many kinds, such as smartweed, elder, sassafras

and grape, small fruits such as grape and blackberry, orchard fruits including apple and sweet cherry, ornamental shrubs, particularly althea and rose, flower garden flowers of all kinds, field crops such as clover blossoms, soy beans and corn, and shade and timber trees including linden, birch, oak, elm and horse chestnut. The beetle does not defoliate, but rather skeletonizes the leaves which often turn brown and drop off. In this way grape vines are riddled, entire orchards of apples appear brown because of the injury, even shade and timber trees are similarly browned to the tops. Clover flowers are eaten and the silk of corn cut off in such a way as to prevent proper fertilization and there is every reason to believe that injury to these crops can acquire a considerable importance. The insect is not, according to Professor S. I. Kuwana, a pest of great importance in Japan, although it does occasionally damage grape and soy bean, the latter especially. The fact that this beetle is of little importance in its native home only indicates that it is there held under reasonable control by natural conditions or natural enemies, or both. The data at hand indicate that the species has every ability to be a pest of prime importance to the agricultural interests of almost any community where it becomes established unless held sufficiently in check by natural enemies.

Difficulties of Control

The insect is a strong flier, very active, easily carried in vehicles, on one's person and on marketable foodstuffs, flowers, etc., as has been repeatedly demonstrated, feeds on a large variety of crops including the lowest growing plants to the largest timber trees, spends a greater part of its life underground where it is difficult to reach, multiplies with remarkable rapidity and lacks its native natural enemies. For these reasons and because it has become so firmly established, because the conditions in Burlington and Camden Counties, New Jersey, where it occurs are so favorable for the insect,—the headlands, fence rows, creeks, and roadsides being grown up and forming a network of favorite food plants and breeding grounds—and finally because the beetle is only moderately affected by poison and is strongly repelled by practically all arsenicals, the species is difficult to control and apparently impossible to eradicate without the expenditure of very large amounts of money. Prevention of spread is difficult, but not impossible and with the plans now under way and a quarantine service, as anticipated, we have every reason to believe that spread another season will be appreciably minimized.

Limits of Infestation

The green Japanese beetle is known to occur in the United States only in portions of Burlington and Camden Counties, New Jersey.

There is a possibility that beetles have been carried out and become established outside of the known infested area, but the limits of the infested area are as nearly accurately known as the most careful study by competent men can make them. This conclusion is reached because: (1) Throughout the season of beetle flight experienced men were kept continuously scouting the outskirts of the known infestation and constantly making beetle collection excursions into the outlying territory;[1] (2) Every report of supposed Japanese beetle occurrence outside of the area, both in New Jersey and Pennsylvania, was traced out but with negative results in every case; (3) Areas of favorite food plants on the west side of the Delaware river in Pennsylvania were carefully scouted for the presence of the beetle just after the close of the period of maximum spread without finding the beetle; (4) This imported beetle has been well advertised by the distribution of colored poster charts, newspaper articles and specimens themselves in all sections of the United States and Canada and regardless of this publicity we have received no report of the occurrence of the beetle outside of the reported findings in New Jersey and Pennsylvania, all of which were investigated as already noted.

The area known to be infested is now about 15,000 acres as compared with 4,000 acres or more in 1918 and the rate of spread during the past season has averaged about one mile with a maximum spread of three miles in any one direction. The beetles began to issue the last of June and reached their maximum abundance early in August and although they were present until the last of October this past year the date of maximum spread was August 30.

Object and Plans

Owing to lack of the necessary funds and for other reasons already noted plans for eradicating the green Japanese beetle have been laid aside. Our project is now to control the bettle and to prevent, so far as possible, the further spread of the insect and at the same time to discover practical control measures and introduce the natural enemies from Japan.

Methods of Accomplishing These Objects

1. The Introduction of Native Natural Enemies is a logical undertaking and plans are being made to send a thoroughly equipped entomologist to Japan to spend not less than a year in that country studying the conditions in relation to the beetle, the parasites attacking

[1] Accurate records of beetle occurrence were kept by using maps printed on cross-section paper, the perpendicular lines lettered and the vertical lines numbered; thus in the notes a record at A25 shows that the beetle was found within an area of 264 feet of where vertical line 25 crosses perpendicular line A.

it and sending to this country such parasites as may be practical. Although the Japanese entomologists know nothing about the parasites of *Popillia* in Japan, we know that white grubs, so called, all have their insect parasites and it is reasonable to assume that *Popillia* is not an exception, and that effective parasites, probably digger wasp parasites of the grub, will be found. We already have one good example of white grub control by an introduced parasite, namely *Anomola orientalis*, which is reported to be well under control in Hawaii following the successful introduction of a digger wasp (*Scolia manilæ*) from the Philippines. Incidentally it might be mentioned that through the coöperation of Mr. Otto Swezey we received from Hawaii this past fall living *Scolia manilæ* adults and while these wasps paralyzed the grubs of *Popillia* they did not oviposit thereon.

In addition to insect enemies from the home of the Japanese beetle, it is planned to establish a large colony of English pheasants, which we know to be very fond of this beetle.

2. To Prevent Spread is of paramount importance and we hope to accomplish this by quarantine, educational measures, roadside clean-up, barrier band and the reduction of the insects in the heaviest infested areas.

(a) *Quarantine.* Since it was known that the beetles frequented corn fields and concealed themselves beneath the husks of corn, thus affording easy means of carriage to outlying districts without being noticed, a quarantine covering green corn was effectively enforced in 1919. The quarantine was fully justified and observations illustrate the importance of a stricter quarantine next season. A quarantine requiring a strict certification of all foodstuffs and other products likely to carry the beetle is anticipated. The quarantine service will be fully treated in a paper by Mr. Hadley who had charge of this phase of the work the past season.

(b) *Educational Measures.* By educational measures, meetings, neighborhood discussions and personal contact it is planned to familiarize the residents of the infested area and that surrounding with the insect and to secure their coöperation in taking every precaution when traveling out of the infested territory and especially to discourage the carrying out of flowers and plants during the beetle flight and plants with soil at all times. Circular letters containing information on the work, our progress and plans and timely coöperative suggestions are mailed to the residents of the infested and surrounding territory about once a month and these together with the meetings have done much to secure the needed coöperation.

(c) *Roadside Clean-up.* To minimize the chances of beetles entering vehicles and thus being carried out, the roadsides throughout the beetle

area and that surrounding are being cleaned up. This clean-up work consists in cutting all wild shrubs and small trees along roadsides and back about 10 feet on either side. After cutting the brush is piled, oiled if necessary, and burned. For these purposes the implements most useful are the bush scythe, axe, bush hook, bush axe, hay fork and manure hook. In cases where the vegetation is dense and especially where it consists of briers and berry bushes, difficult to clean out by hand, it is burned direct, using a fuel oil flame. Such a flame produced by forcing the oil through the spray nozzle, preferably one giving a fine, fan-shaped spray, is intense and very effective in burning standing green vegetation.

This work is being rapidly pushed this winter and next spring it is planned to salt these cut-over areas, using salt at the rate of about three tons per acre, to prevent a regrowth. According to Mr. W. Rudolfs, research student at Rutgers College, who is making a special study of the uses of salt for agricultural purposes, the salt acts as a destroyer of plant life when it is broken up into its component parts and the chlorine taken up through the roots thus poisoning the plants and preventing the proper functioning of the plant cells. Consequently the salt applications will be most effective when applied in spring as plants are actively growing and when a rain follows shortly after the application. Heretofore we have used arsenical weed-killers and while they are quite effective they have the disadvantage of making the vegetation poisonous to cattle, which is a serious objection as anyone who has had experience with control projects will agree.

(d) *Barrier Band.* It has been planned to construct a so-called barrier band completely around the area extending at least one-half mile beyond the exteme limits of known beetle infestation. In this band it is planned to cut, burn and salt all roadsides, headlands, fence rows, brushy woodlots, creek banks, in fact every area where wild vines and shrubs were growing excepting timber patches and to make it as free from favorite feeding and breeding places as practicable, and in addition to make this area undesirable for the beetles by keeping the remaining vegetation thoroughly coated with a repellent during the beetle flight. Heretofore a dust of arsenate of lead and lime (20–80) has been used, and while this material is an effective repellent it is poisonous to animals and on account of the scattering pasture lands a complete band could not be maintained. Sulphur and lime as a dust and lime-sulphur solution will hereafter be used as they are very effective repellents and are not poisonous to cattle.

As long as the extensive headlands, ditch banks, fence rows, etc., continue in their present condition, that is, grown up with favorite food plants of the beetle, thus forming a network throughout and

extending beyond the infested area, the beetles will continue to have ideal and easy means of traveling out and establishing themselves in new areas at a rapid rate. With these favorite food plants eliminated the beetles find it much more difficult to spread and there is far less opportunity and chance of their entering vehicles or fruit and vegetable packages and in this way being carried away. A scarcity of favorite food plants and breeding areas naturally interferes with the unrestricted multiplication of the beetle, and likewise such conditions will also make it necessary for the beetles to concentrate on fewer plants and in fewer places, thus making the hand collecting of beetles more profitable and the scouting more efficient.

In this connection the War Department was requested to coöperate to the extent of mapping the area, the object being to photograph and prepare a mosaic of the area from an aeroplane, to enable us to plan our clean-up to better advantage and to impress more clearly upon the farmers the needs of clean-up work on their individual farms. The War Department detailed an outfit for this purpose, but owing to the foggy conditions and equipment unsuited for these conditions satisfactory photographs were not obtained, but the work will probably be repeated next spring under more favorable conditions and with equipment better suited for our needs.

For the entire project it was estimated that a minimum of $70,000, in addition to the funds already appropriated, would be necessary and consequently this amount was requested. Of this amount $45,000 were granted and since it is impossible to construct and maintain a barrier as planned we are now endeavoring to secure the coöperation of the individual farmers to clean up according to our directions. Whether the coöperation will be sufficiently general to enable us to complete and maintain the barrier cannot be foretold.

3. To Reduce Their Numbers it is planned to continue hand-collecting the beetles, cyaniding to destroy the grubs and to secure the coöperation of farmers to the extent of following certain agricultural practices.

(a) *Hand Collecting.* The past season collectors were employed to collect beetles in the heaviest infested areas, but only at such times as when inspection and similar work permitted. Boys were encouraged to collect beetles for which we paid 60 cents a quart (average 3,376 beetles) early in the season and 80 cents later on. In this way we destroyed approximately one and one-half millions of beetles, at least 40 per cent of which were females. Hand collecting is believed to be very profitable, especially since the use of arsenicals is impractical, from our present knowledge, and this method will be pushed another season.

(b) *Soil Insecticide Operations.* Soil insecticide tests using sodium cyanide as the insecticide begun by Mr. Goodwin in 1918 have been continued and the amounts and methods of application are now quite satisfactory, giving us a kill of 90 to 100 per cent. The equipment consists of 600-gallon tanks drawn by caterpillar tractors. The flow is by gravity through 3 inch pipe with $\frac{3}{8}$ inch holes, 48 holes to a foot, and covers a strip 7½ feet wide, the flow being governed by a gate valve, which can be operated by the tractor driver. The rate of applicatiou which has been found quite effective is 165 pounds of granular sodium cyanide in 12,000 gallons of water per acre. The cost of the insecticides and labor necessary is approximately $56 per acre and is too expensive for general use, but for small areas and in the case of the green Japanese beetle for large areas where the grubs are abundant and where larger expenditures are permissible from the standpoint of controlling an insect occurring only in a comparatively small isolated locality. To determine the area of heavier grub infestation and the fields sufficiently infested to be cyanided, individual square yards in different parts of the field are examined. For this purpose a hazel or grub hoe with a thin blade is very useful.

In cyaniding, Mr. Hadley, who had charge of the soil insecticide work this fall, found that three tanks and two tractors can work most economically. Two men drive the tractors while one remains at the filling station mixing cyanide and filling the extra tank. As one tank is emptied, it is hauled to the filling station and a filled tank taken out. In this way the two tractors and three men lose no time and the three tanks are capable of covering three acres per day, that is, each tank treats one acre per day applying in this time 12,000 gallons of liquid. The water used in this work must be obtained largely from creeks nearby, and is pumped by a centrifugal pump. Along roadways where it is not possible or desirable to block the road two stand pipes are used, but in a field where it is possible to haul the tanks on either side of a pipe only one water pipe is needed.

The important points in applying cyanide are that the holes be sufficiently small to allow a uniform screen of water which will quickly and thoroughly penetrate the soil, that the grubs be within two inches of the surface and that the temperature of the soil be above 48° F. At the rate of 165 pounds of cyanide per acre the grass is burned, but is not destroyed except in spots where the liquid stands. At the rate of 110 pounds per acre the burning is comparatively little and while this strength gives a kill practically equal to the greater strength when conditions are optimum our observations indicate that 165 pounds gives an effective kill over more variable and less favorable conditions.

4. Experiments and Investigations. Up to the present time the

investigations have been largely studies of the life history of the insect. Observations prove that most poisons, however applied, are decided repellents and further that the beetles are not readily killed even when they feed on poisoned foliage. A few experiments conducted the past season show that certain essential oils, especially lemon oil, and certain fruity or fermentation odors are attractive to the beetles, but when added to a spray solution the attractive odor usually disappears as soon as the spray dries. There is every indication that iron arsenate in solution has an attraction for the beetles, but it is not sufficiently poisonous to kill the beetles, although it is believed that a combination with another poison which will retain the attractiveness and be an effective posion can be obtained.

Coöperation

To accomplish the control of the green Japanese beetle the thorough coöperation of all residents of the area is essential. Coöperation is asked to the extent that they (1) use every care to prevent the accidental spread of the insect in vehicles, on one's person, with flowers, food products, etc., (2) clean up all headlands, fence rows, ditch banks, scrubby woodlots, and roadways on their premises, (3) hand collect beetles wherever possible, (4) plant wide row crops so far as possible and keep them thoroughly cultivated and plant a minimum acreage of green corn, because the beetles can be carried so easily on this crop, (5) to adhere strictly to the quarantine regulations, (6) to plow infested ground in the fall and to plow or deeply cultivate infested ground as thoroughly as possible in late May and during June when the grubs are transforming from grub to pupa and from pupa to adult.

REPORT OF THE SOUTHERN NURSERYMEN'S ASSOCIATION

By Paul C. Lindley, *Vice-President, Pomona, N. C.*

Mr. Chairman and Gentlemen:—

At the annual meeting of the Southern Nurserymen's Association at Atlanta the past August, a committee was appointed to report on uniform inspection regulations for all states.

The entomologists present at the Nurserymen's Convention advised that this report be presented at their annual meeting in St. Louis. The executive committee of our Association was unable to persuade one of our orators to meet with you, I suppose the "14 Points" in the report, coupled with the fact that uniform law must be an old story at your meeting, he feared to open the subject again.

The following is the report of committee:

COMMITTEE REPORT ON UNIFORM NURSERY INSPECTION REGULATIONS, FOR DECIDUOUS NURSERY STOCK

Your committee appointed for the purpose of looking into the matter of attempting at least the formulation of Nursery Inspection Regulations that may be adopted by all the states of the union with the idea of simplifying things, called into their session yesterday Mr. Lewis, State Entomologist of Georgia, Mr. Bentley, State Entomologist of Tennessee and Mr. Starcher, State Horticulturist of Alabama. After a full discussion it is our opinion that the following regulations could be adopted by all the states:

1. All inspection certificates to expire August 31 of each year.
2. All nurseries must be equipped for fumigating, or dipping, or must fumigate, under permit, with some one who has proper fumigation or dipping equipment, and must fumigate or dip all nursery stock subject to San José Scale, and Aphis attack, when required by state laws or requested by purchaser.
3. A printed copy of certificate of inspection must be attached to each shipment, said certificate to be printed on shipping tags.
4. All shipments must be marked to show names and addresses of consignor and consignee.
5. Attached to each container of shipments of nursery stock a certificate of fumigation or dipping when said shipments have been fumigated or dipped.
6. A duplicate copy of certificate of inspection must be filed by all nurseries with the official State Entomologist or other designated officer in each state.
7. A statement that the nursery is equipped for fumigating or dipping, or has made arrangements for this work under permit with some one properly equipped, must be filed with each State Entomologist, or other designated official.
8. The importation of five leaved pines be prohibited.
9. The importation of currants and gooseberries be prohibited, except by special permit.
10. The importation of citrus stock be prohibited, except as provided for by citrus regulations.
11. That hardy greenhouse stock be included in the regulations.
12. The importation of barberries except as permitted by Federal Horticultural Board be prohibited.
13. That the license fee either for nurseries within the state or outside the state be eliminated.
14. That the Southern Nurserymen's Association pledge itself to aid in every possible way the passage of the necessary state laws providing ample funds for the support of the entomological work in each state.

Respectfully submitted,

O. W. Fraser,
E. W. Chattin,
Paul C. Lindley,
Charles T. Smith,
H. B. Chase, *Committee.*

1. All inspection certificates to expire August 31 of each year.

A date not later than September 15 should be agreeable to all states, if August 31 is too early. Quantities of coniferous evergreens are moved in August. The earlier date is more convenient for the trade on account of delay in getting their printed matter.

2. All nurseries must be equipped for fumigating or dipping.

Both good, if I were planting an apple orchard would prefer and want the trees dipped. For several years we have dipped our apple scions in soluble oil before grafting with good results.

6. On receiving and filing our signed duplicate certificate of inspection, giving us the right to ship nursery stock to any state where we conform to their laws, what more should be necessary?

There is just one point I want you gentlemen to seriously consider when your inspector visits the various nurseries in their respective states. Provide him with a blank report to file with all state officials giving condition of stock, if any cutback seedling peaches or nut trees, seedlings in yearling blocks of trees. In this way each state would have a report of all nurseries and a little watchful waiting I believe would clear up what is said to be some bad nursery practices.

10. The group of citrus states will have their separate regulations in addition to the uniform law.

13. License Fees.

Works hardship on all nurseries having sometimes only one order to a state. Puts the little fellow out of business. We have quite a lot of requests for catalogues from states adjoining the South Atlantic group, but on account of the laws all we can do is to write them a letter and tell them on account of prevailing state laws, we can't ship to their state. The nursery interests will help you get more revenue from other sources as outlined in article No. 14.

Numbered Tags

While sent here by the entire Southern Association it is the retail nurserymen who are specially interested. For the wholesale nurserymen whose shipments consist of bulk cars and several boxes for each individual order, numbered tags have no worry.

It is humiliating and rather embarrassing to be brutally frank in regard to a group of nurserymen in one of our southern states, which is the cause of laws in the states of South Carolina and Mississippi that a numbered tag shall be on each package, box or bale and copy of order filed in few days with the state officials. Now if this law is necessary in the states of South Carolina and Mississippi, why isn't it necessary in all states?

Returning to the states of South Carolina and Mississippi—there is only one nursery in South Carolina and I don't know of any in Mississippi doing a retail business. Most certainly the officials in charge should protect the people, when practically all trees come from *other* states. The only way of knowing in what districts certain nurserymen are working is by the copy of each order required on day of shipment.

Now, gentlemen, please don't get the impression that I am arguing against your laws, for I approve of all but one of them. I will try to show you why the Southern Nurserymen belonging to the Southern Association do not like numbered tags.

I will take my firm and endeavor to show our methods of filling an order. Our orders come in during the summer before we have a certificate and are tagged as follows: All fruit trees on one tag that goes to that department. If shrubs are ordered the same number is used but different tag. Different departments handle the grape, roses and strawberries, and are shipped from one of our branch nurseries eighty miles away. Pecans are tagged separately and shipped direct from Florida. We usually ship several thousand orders and have only 30 days to do the work. We were forced to put on extra help to take care of the tag end of the business. Along would come a countermand, and perhaps the customer had purchased only nut trees and his number was in Florida, or if only roses and berries, at our branch nursery. Quite a lot of red tape and very costly in *time* during the fall shipping season.

If all the states in which we do business required a copy of each order and a numbered tag, we would discontinue our agency business. We had one delivery of several hundred orders at one point in Mississippi this season. It will give you some idea of time to wire a tag to each order and stamp the duplicate number on our tag and the duplicate to go to the state department. Now one of our best men has to oversee the new girls doing this work or it will be balled up and we get "bawled out."

Now this same group of nurserymen, who I judge is the cause of our tag law, do not belong nor can they join our Southern Association if they wished. I was informed by one of our state officials that he saw a shipment of acre orchards in which the peach were all labeled different varieties, but the trees were dormant buds and part of the buds dead. They also agree to spray and trim for certain length of time. Do numbered tags correct this evil? We have laws against frauds, can't our state officials handle such practices under that act?

Coöperation

You are directly interested in the fruit business and we trust your organization will support measures for the benefit of the nurseryman as well as the planter.

The buyer whom you are trying to protect would purchase few trees from a catalogue, but waits for the annual trip of the tree salesman. Though there are many crooked ones, taken as a whole they have been a blessing. I know of one man who has worked the same town and county in Alabama for thirty-five years. Usually, though, a great number of them do not return after the trees begin to fruit.

Not all mistakes are made by the much cussed tree agent or the nurseryman. During the past few years inefficient and short supply of labor have been the cause of many mistakes. Cutting buds and careless handling by irresponsible workmen causes many mistakes; especially is this so with the peach. The peach is the hall-mark of the crooked nurseryman. He can mow off the seedlings with a mowing machine and give them the appearance of budded stock, can bud them and if a bud dies, let a sucker come or just plant a block of seed and cultivate them. I know of one block of peach the past season that, owing to a poor stand of buds, contained many thousands of seedlings that looked like first class trees at digging time. When that block of trees were shipped the weather was bad, they were ordered out by wire, consequently the purchaser received many hundreds of seedling trees. I believe that nurseryman intended to be honest but was keeping his overhead expense down by employing inferior labor during his busy season.

Conclusion

What shall we do?

Now what will the nursery interests represented by the Southern Association do if we have a uniform law? Article VII of their Constitution says:

"It shall be the duty of every member to report to the executive committee hereof, any character of dealings on the part of Association members not in accord with established business ethics. The secretary shall once each year provide each member with blanks for ballot, upon which he shall make a report, and in case any member shall receive three or more adverse reports, the executive committee shall immediately make such investigation as will develop all the facts in the case, and bring their report before the next annual meeting of this Association. If, upon evidence deduced, it is proven that such members' dealings violate established ethical relations, he shall be expelled from this Association upon a majority vote of the members present at any annual meeting, provided each member shall have the right to be heard in his own behalf before such action is taken."

Sometimes it is a hard proposition and a serious one to be able to determine whether

the nurseryman is crooked or whether the people who accuse him are trying to get something for nothing when they say unfair dealings. But if any state official will report to our secretary any nurseryman who ships say peach with nematode roots and will not adjust the matter satisfactorily to all concerned, the Association will try to see that both parties have a satisfactory adjustment.

Coöperation is the order of the day and we want to help you.

Teach your inspectors to be a help in place of a scare. A few years ago the nurserymen growing fruit trees were in the clutches of an epidemic "the jumps" on receipt of a postal saying the inspector would arrive on a given date. They should look for seedlings as well as scale, and give the nurserymen helpful criticism, in order that they may improve their methods.

THE GREEN JAPANESE BEETLE QUARANTINE[1]

By C. H. HADLEY, *Riverton, N. J.*

The primary purpose of any insect quarantine is the prevention of its further spread, but before any quarantine can be imposed, a thorough study of the insect in question is of course necessary, with particular reference to the conditions which may cause, aid, or restrict, directly or indirectly, distribution and spread of the insect. Since a discussion of the green Japanese beetle problem as a whole has already been given at these meetings, it is only necessary here to give a brief statement of the conditions which necessitated the placing of this quarantine.

It is known that the green Japanese beetle (*Popillia japonica* Newm.) was accidentally imported into Burlington County, New Jersey, from Japan sometime previous to 1916, probably as a grub in the soil about the roots of perennial plants. It was discovered during the month of August, 1916, by inspectors of the New Jersey State Department of Agriculture. Observations during the seasons of 1917 and 1918 showed that the insect was capable of reproducing at an amazing rate, and unless soon checked would, undoubtedly, develop into a pest of very considerable importance. It was further ascertained that the danger of the insect being carried from the infested territory on farm produce, especially green or sweet corn, was very great. Accordingly after necessary public hearings were held, quarantine order number 35, restricting the movement of green, sweet or sugar corn interstate from the infested districts, was published by the Secretary of Agriculture, to be effective June 1, 1919. This quarantine was shortly after supplemented by a similar measure, promulgated by the Secretary of Agriculture of the state of New Jersey, regulating the intra-state movement of green or sweet corn from the infested territory.

The territory designated as the area under quarantine comprised the townships of Delran, Cinnaminson and Chester, all in Burlington

[1] Published by permission of Secretary of Agriculture.

County, New Jersey. In addition to this territory, the intra-state quarantine order included the township of Palmyra and the Borough of Riverton in the area subject to quarantine. The regulations also provided for the thorough cleaning of all vehicles employed in the transportation of this product. The details of the rules and regulations of the state quarantine order were identical with those of the federal quarantine, already in force, and their enforcement delegated to the representative of the state already attached to the green Japanese beetle force. In effect, the representative of the Federal Horticultural Board was directly responsible for the enforcement of both quarantine orders without further distinction.

In enforcing the quarantine regulations, the following methods of precedure were adopted. Early in the spring of 1919, a questionaire, together with a map of the infested territory on which the location of the farm could be indicated, and a copy of the regulations, were sent to every resident of the quarantined area who owned or rented five or more acres of land. In this way it was possible to determine what farms were growing sweet corn, what proportion was intended for home consumption and what for sale, where it was to be shipped, location and other data of importance in carrying out the provisions of the quarantine.

This territory was roughly divided into three districts, (1) including those farms within the quarantined area, but well outside the known limits of infestation; (2) those farms within the probable limits of infestation, but not as yet actually infested; and (3) those farms known to be actually infested.

For the first district, "blanket" certificates were issued to each farmer growing green or sweet corn for sale, allowing unrestricted shipment of their product up to August 15, or until revoked for cause. It was expected that the limits of a possible spread of the beetle would be known by that time, and after that date the certificates were extended for the balance of the season, except where circumstances did not warrant such action for individual cases.

For the second district, similar "blanket" certificates were issued, valid until July 25, or until revoked for cause. It was anticipated that by that time the outlying points of infestation would be definitely known. After that date, the certificates were extended if circumstances warranted; otherwise the farm in question automatically fell in the third classification.

For the third district, comprising those farms known to be infested in greater or less abundance, no "blanket" certificates were issued, but actual inspection and certification of every package of corn was required before it could be moved from the farm. Throughout this

locality, the practice of packing green corn in baskets holding five-eighths of a bushel (known as five-eighths baskets) is almost universal. The usual method is to cut or pull the ears in the field, pile them in a shaded place nearby, and then pack them in baskets to await shipment. Occasionally a grower has a packing shed or house in which the final packing is done. The inspection was made after the ears were piled and before packing. The inspector examined each ear, and in the case of suspicious appearing ears, the husk was torn down. It was soon learned that normal ears, on which the husk was perfectly tight and the silk uninjured in any way, offered no concealment for the insect; on the other hand, ears with a loose husk, or in which the husk was eaten by other insects (especially by ear worm), or in which the silk was eaten or missing, or ears in which the husk did not entirely cover the tip of the cob, or ears deformed by some disease or other cause, were almost invariably the ones harboring the beetle. Occasionally a beetle was found on the outside of the husk or silk, but usually any of the insects which may have been in such exposed places had been knocked off in the handling of the ears. It was noticeable that the infested ears were usually found early in the morning; apparently the beetles left their shelter as the air became warmer.

During the course of the season, something over 23,000 baskets of corn were examined, in which a total of seventy-seven (77) beetles were found, in practically every case the beetle or beetles being found beneath the husk. The corn ear worm was abundant during the past season, especially on the earlier varieties of green corn, and often their feeding places on the corn furnished hiding places for the beetles.

In the opinion of those engaged in the green Japanese beetle project, the quarantine has been abundantly justified, in the finding of these seventy-seven beetles which would otherwise have escaped from the infested territory. While apparently this number is small in comparison with the number of baskets of corn examined, these relatively few beetles assume a much greater importance when the amazingly rapid rate of increase of which this species is capable, is considered. It should also be noted that in every case in which the shipments were found to be infested, the corn was destined for the Philadelphia market, from there perhaps to be scattered in small lots to points further removed from the present infestation.

All shipments of green corn made via railroad or mail were also inspected and certified. For such shipments, special forms for certification were required.

Throughout the season, as opportunity offered, other farm products were examined, in order to determine to what extent they might serve as means of dispersing the insect. The methods in common use for

the disposal of most farm products from this district are in many instances very favorable to the further dispersal of the beetles, and those in charge of the work are convinced of the need of additional quarantine measures, to remedy this situation. Not only will the area now subject to quarantine need to be very considerably enlarged, but it seems probable also that the shipment of practically all outdoor grown farm products will have to be subject to quarantine regulations. A revised quarantine measure is now being drawn up, which we believe will fully and adequately cover all phases of the situation, so that the chances of further spread by this means will be reduced to the very minimum.

At 3.40 p. m., the meeting of the Association was called to order.

PRESIDENT W. C. O'KANE: We will resume the program and the next paper is "A Preliminary Report on the Use of Sodium Cyanide for the Control of the Peach Borer," by Alvah Peterson.

A PRELIMINARY REPORT ON THE USE OF SODIUM CYANIDE FOR THE CONTROL OF THE PEACH-TREE BORER (SANNINOIDEA EXITIOSA SAY)

By ALVAH PETERSON, *Assistant Entomologist, New Jersey Agricultural Experiment Station*

INTRODUCTION

For two seasons we have been studying the response of the peach-tree borer and peach trees to sodium cyanide. In 1916, Mr. M. A. Blake and Mr. C. H. Connors, of the New Jersey Agricultural Experiment Station, started a few experiments with sodium cyanide. They found that strengths up to and including one ounce to one gallon of water did not injure the trees. On the basis of their results one peach grower in New Jersey, who has 3,000 six-year-old trees located on silt loam soil, has treated his orchard for three seasons with sodium cyanide. He applies three quarters ounce to one gallon of water to each tree in September or October. During the past season one ounce of dry sodium cyanide per tree was applied. This orchard today is in excellent condition and the peach borers have been greatly reduced.

In experimenting with poisonous gases or materials for the control of the peach-tree borer some of the important points to consider are the size and location of the larvæ in the tree, the age and condition of the tree, the time and method of application, the penetrative and lasting quality of the poison in the soil and the physical and chemical properties of the soil, particularly its temperature and water holding

capacity. Many of the above phases of the problem are closely related, consequently it is by no means a simple one.

Method of Application

The granulated or liquid sodium cyanide was placed in a shallow trench (2 to 4 inches deep) about the base of the peach tree. After the poison was applied the soil was piled up about the tree to a height of 6 to 10 inches and then tramped down with a hoe. In the liquid treatments (sodium cyanide dissolved in water) the solution was permitted to partially soak into the ground before the dirt was piled about the tree. When the dry granular sodium cyanide was used it was evenly distributed in the trench and not permitted to come directly in contact with the tree.

Response of the Larvae to Sodium Cyanide

What is the minimum dosage which will kill a sufficient number of larvæ to be a practical control (Tables I to II)? In this preliminary report three typical experiments will be discussed. These are taken from a number of experiments conducted under varying conditions in eight orchards throughout New Jersey. Table I shows the results obtained at Clementon, N. J., early in November, 1918, where experiments were conducted under two soil conditions, a light sandy soil and a gravel loam soil. In these experiments the percentage of kill is based on an actual count of the dead and living larvæ found in the treated trees. The percentage of dead larvæ is probably greater than indicated, because in "worming" the trees one cannot be sure that all of the dead larvæ have been found. A dead larva gives no indication of its presence in a tree while a living larvæ does. To remove all of the dead borers would require severe cutting of the trees.

Table II shows the results obtained at Clementon, N. J., in May, 1919. The percentage of reduction in the infestation is very similar to that obtained early in November, 1918. In this table the per-

Table I. The Effect of Sodium Cyanide on Peach-Tree Borers (per Tree) Present in Nine-Year-Old-Trees (Five Trees in Each Plot) in November, 1918, at Clementon, N. J.

Series	Treatment	Living larvæ per tree	Dead larvæ per tree	Total larvæ per tree	Percentage killed
1	½ oz. to 1 gal.	1.6	3.4	5.0	68%
2	1 oz. to 1 gal.	.4	5.6	6.0	93%
3	Check	10.6	0	10.6	
4	1 oz. to 1 gal.	1.2	3.6	4.8	75%
5	1½ oz. to 1 gal.	.4	6.4	6.8	94%
6	1 oz. dry	.8	2.8	3.6	77%
7	Check	5.0	0	5.0	

Series 1–3 in sandy soil.
Series 4–7 in gravel loam soil.

TABLE II. THE EFFECT OF SODIUM CYANIDE ON PEACH-TREE BORERS (PER TREE) PRESENT IN NINE-YEAR-OLD TREES IN MAY, 1919, AT CLEMENTON, N. J.

Series	Treatment	Larvæ per tree (alive)	Reduction (percentage)
A	1 oz. to 1 gal.	1.6	68%
B	1½ oz. to 1 gal.	0.6	88%
C	1 oz. dry	1.0	80%
D	1½ oz. dry	0.0	100%
E	Check	5.0	

Series A–E in gravel loam soil.

centage of kill is based on a comparison of the number of living larvæ removed from the treated and check trees. Heavily infested trees were chosen for these experiments.

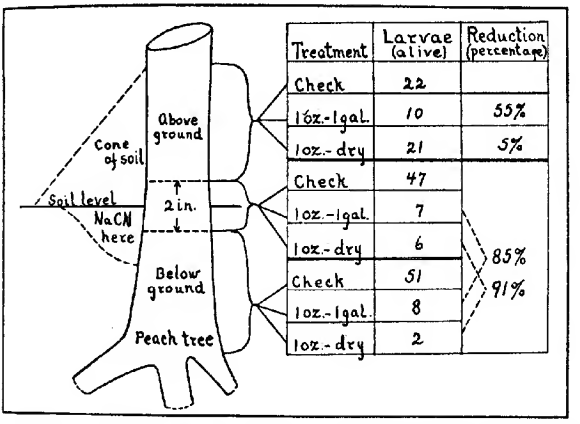


Table III. The effect of sodium cyanide on the total number of larvæ found in the three zones of trees (8 years old). Oct. 1. 1919, Middletown, N. J. Sandy loam soil. Ten trees in each plot.

Table III shows the results obtained October 1, 1919, at Middletown, N. J. Twenty heavily infested trees were selected and treated in this severely infested orchard, ten trees with one ounce of sodium cyanide dissolved in one gallon of water for each tree and ten trees with one ounce of dry sodium cyanide sprinkled in a shallow trench about each tree. When the larvæ were removed, their condition, size and location in the tree was noted. The diagram shows the tree divided into three zones, the top or above ground zone extending from one inch above the soil level upwards and the bottom or below ground zone extending from one inch below ground downwards to and including the base of the large roots. The intermediate zone, where the greatest concentration of larvæ was found, may be called the soil level zone.

The one ounce treatments reduced the living larvæ 85 to 91 per cent in the soil level and below ground zones while above ground the sodium cyanide was not very effective. The dry sodium cyanide did not materially effect the larvæ above ground while the liquid sodium cyanide apparently did (55 per cent). This difference may be due to the fact that in applying the liquid sodium cyanide the poison was poured against the tree above ground. It is probable that a greater percentage of kill above ground would have resulted with the dry sodium cyanide if it had been sprinkled about the tree at soil level and not placed in a trough 2 to 4 inches deep.

The size of the larvæ is not recorded in the tables, but our records show that small larvæ are killed more readily than larger ones. This may be due to the fact that the small larvæ are usually located near the outer surface of the trunk while the large ones may be deeply embedded in the tree. In early autumn the majority of the larvæ are small and located near the outside of the tree. This points to the conclusion that the best time of the year to kill the borers is during September or early in October.

Response of the Peach Trees to Sodium Cyanide

What is the maximum dosage peach trees of varying ages will stand? In Tables IV and V a few of the typical and unusual results are recorded from various orchards. Table IV shows the results obtained with eight- and nine-year-old trees. Two and three ounce treatments killed or injured many of the trees when applications were made in May and June. Similar applications made in October gave the same results. When one and one half ounces and one ounce treatments to a gallon of water were applied in November, 1918, to eight-year-old trees in a gravel loam soil all of the trees died which received one and one half ounces and 20 per cent died which received one ounce. A one ounce dry sodium cyanide treatment was made at the same time and no tree was seriously injured. In the same orchard a number of

Table IV. The Effect of Sodium Cyanide on Peach Trees Eight and Nine Years of Age, 1918–19

Treatment	Date	Soil	Normal trees	Injured trees	Dead trees
½ oz. to 1 gal.	Oct. 29, '18	Sandy	5	0	0
1 oz. to 1 gal.	Oct. 29, '18	Sandy	5	0	0
1 oz. to 1 gal.	Nov. 10, '18	Gravel loam	4	0	1
1½ oz. to 1 gal.	Nov. 10, '18	Gravel loam	0	0	5
1 oz. dry	Nov. 10, '18	Gravel loam	5	0	0
1 oz. to 1 gal.	May 15, '19	Gravel loam	3	0	0
1½ oz. to 1 gal.	May 15, '19	Gravel loam	3	0	0
1 oz. dry	May 15, '19	Gravel loam	3	0	0
1½ oz. dry	May 15, '19	Gravel loam	3	0	0
2 oz. dry	May 15, '19	Sandy	1	2	0
3 oz. dry	May 15, '19	Sandy	3	0	0
3 oz. dry	June 7, '19	Sand loam	0	0	5

trees were treated during May, and June, 1919, and September, 1918, with one half and one ounce and they were not affected. It is probable that November is too late in the year to safely treat trees with NaCN, particularly when applied in liquid form. In all our experiments with sodium cyanide a one ounce treatment (liquid or granular form) has not seriously injured or killed five- to ten-year-old trees when applied in May, June, September, or October.

TABLE V. THE EFFECT OF SODIUM CYANIDE ON PEACH TREES TWO TO FOUR YEARS OF AGE, 1917–19

Treatment	Date	Soil	Age of trees	Normal trees	Injured trees	Dead trees
*½ oz. dry	June 4, '19	Sand loam	3	6	2	2
*1 oz. dry	June 4, '19	"	3	3	2	5
½ oz. to 1 gal.	July 23, '17	"	2	2	0	0
¾ oz. to 1 gal.	July 23, '17	"	2	2	0	0
1 oz. to 1 gal.	July 23, '17	"	2	1	1	0
2 oz. to 1 gal.	July 23, '17	"	2	1	0	1
½ oz. to 1 gal.	July 23, '17	"	4	2	0	0
¾ oz. to 1 gal.	July 23, '17	"	4	2	0	0
1 oz. to 1 gal.	July 23, '17	"	4	2	0	0
2 oz. to 1 gal.	July 23, '17	"	4	1	1	0

*Trees in this orchard (Middletown, N. J.) severely injured by winter kill (1917–18).

Table V shows the results of a few experiments with two- to four-year-old trees. The results indicate that healthy trees will stand one half to three quarters ounce of sodium cyanide without injury. Trees that have been weakened by winter kill or heavily infested with borers may be injured or killed by these strengths.

When sodium cyanide injures the trees the leaves and fruit wilt. The leaves gradually turn yellow and drop off. The behavior of an injured tree is somewhat similar to trees injured by drought. Injury, due to applications made during May and June, usually makes its appearance a week or two after the material is applied. In some instances the injury may not show for several weeks. Trees injured by heavy doses of sodium cyanide in September, October, or November, do not always show their injured condition at the time the leaves and flowers appear the following season. The trees may give rise to normal leaves and flowers and then later in the season (June and July) the leaves and fruit may show a wilted condition. This wilted condition may exist several weeks before the trees die.

SODIUM CYANIDE IN THE SOIL

So far as known the peach-tree borers are killed by the fumes arising from the sodium cyanide. The salt undergoes rapid decomposition after it is placed in the soil. One cannot detect an odor of cyanide in the soil three weeks after a one ounce application has been made and a

chemical analysis will only show a trace. In five weeks a chemical analysis of the soil fails to show a trace of cyanide. When two or three ounce treatments have been made a faint trace of cyanide (chemical analysis) will exist in the soil adjacent to the tree five weeks after the applications have been made. It was also observed that sodium cyanide disappears sooner in liquid treatments than when the dry granular material was used.

The physical and chemical consistency of the soil has some bearing upon the use of poisonous gases for the control of the peach borer, but its importance (when using sodium cyanide) has not been thoroughly worked out. Our experiments show that one ounce treatments produce a greater percentage of dead larvæ when the trees are situated in light sandy soils than when located in heavy soils. This may be due to the fact that the gas penetrates light soils more rapidly and to a greater distance than heavy soils. Heavy soils are usually water laden and this may prevent a rapid and thorough distribution of the gas. The water holding capacity of a soil may prove to be an important factor in the use of sodium cyanide and other poisonous gases.

Time of Application

The time of application is important. Our results show that applications in May, June, September, and October, give the best results in killing the larvæ and is the safest for the tree. As yet the results do not conclusively show which of these months is the best; however, I am of the opinion that the last week in September or the first week in October will probably be the best time in New Jersey. At this time all of the eggs have hatched and the majority of the young larvæ will be found on the outside of the tree or just beneath the outer surface of the bark.

Summary

Sodium cyanide is a very poisonous substance; consequently one must use extreme care in making applications. On account of the poisonous nature of sodium cyanide it is doubtful if anyone would deem it wise to make a general recommendation to peach growers for its use.

From a scientific standpoint it has been interesting to note its influence on the larvæ and the peach trees. The results obtained may give us some information on the use of other substance such as paradichlorobenzene. During 1919 we used paradichlorobenzene in two orchards, but our experiments to date are not sufficiently extensive or conclusive to give the results at this time.

One ounce treatments (liquid or granular form) of sodium cyanide will kill 75 to 90 per cent of the larvæ in five- to ten-year-old trees.

The granular or dry sodium cyanide is just as efficient as the liquid (one ounce to one gallon of water) and much easier to apply. One half ounce and in many cases three fourths ounce treatments for five- to ten-year-old trees will not kill a sufficient number of larvæ to constitute a practical control.

Vigorously growing peach trees five to ten years of age have not been injured by one ounce treatments when the applications were made in May, June, September, or October. Also healthy trees two to four years of age have not been injured by one half ounce treatments.

ACKNOWLEDGMENTS

I am indebted to Mr. C. H. Connors and Mr. M. A. Blake for valuable information concerning their results with sodium cyanide. I wish to thank Dr. T. J. Headlee for many important suggestions received. I am also indebted to a number of peach tree growers in New Jersey who have permitted me to carry on investigations in their orchards.

MR. O. I. SNAPP: I would like to ask Mr. Peterson how close to the tree trunk the material was placed?

MR. ALVAH PETERSON: In the liquid treatments, a trough was dug about the tree two to four inches deep; the liquid was poured into the trough so that it came in contact with the tree. In the dry treatment fine, granular sodium cyanide was used. This was sprinkled in the trough about the tree. The majority of the sodium cyanide would be an inch or two away from the tree.

MR. G. G. BECKER: In order to get a little more definitely at the direct state of application, I would like Mr. Peterson to tell us about the time of emergence of the moth in New Jersey, and whether the applications were used then or not.

MR. ALVAH PETERSON: For three seasons we have been studying the peach-tree borer; the first year was devoted largely to a life history study in New Jersey and also a preliminary study of various methods of control. We find that the majority of adults emerge in August. They start to come out about June 15 and some may be found as late as September 15th, but the greatest number come out the first two weeks in August. I have found eggs on the trees as late as September 20th.

We made applications in May, June, September, October and November. I am of the opinion that in using a toxic gas for killing the peach-tree borer, it would be advisable to make the application late in September or early in October. I would not put it off too late in the season due to the fact that the soil becomes cold and the larvæ

are less active; consequently, they are not as easily killed, and furthermore the poisonous material may also have some effect on the peach trees.

PRESIDENT W. C. O'KANE: The next paper is "Dust versus Spray for the Control of Sour Cherry Pests in Pennsylvania," by J. G. Sanders and D. M. De Long.

DUST VERSUS SPRAY FOR CONTROL OF SOUR CHERRY PESTS IN PENNSYLVANIA

By J. G. SANDERS and D. M. DELONG, *Harrisburg, Pa.*

The northern portion of Erie County, Pa., contains approximately ten thousand acres of fruit orchards and vineyards. In this area the growing and marketing of sour cherries is a considerable factor. Due to local conditions adjacent to Lake Erie, the usual pests affecting sour cherry, such as curculio, slug and leaf spot disease, are more or less destructive, varying considerably from year to year. In this Lake area, as was noted in similar conditions in Wisconsin, the cherry slug is unusually destructive throughout a strip four to five miles in width—adjacent to the Lake.

The damage from curculio, slug and leaf spot was exceptionally serious in 1918, and following requests for help from the growers, a series of experiments was carried on during the summer of 1919 to determine the relative value of dust and spray mixtures for pest control. Sour cherry trees six years of age, comprising four blocks, 12 trees in width and 34 in length—with a check plot 3 by 12 trees, were selected at one end of a large cherry orchard. The test plots were bounded by vineyards on the east, north and west, while the continuation of the orchard was to the southward. The remainder of the orchard—not included in the test—was sprayed three times by the owner with commercial lime-sulfur solution, 1 to 40. The prevailing winds in this section are from the southeast, blowing diagonally from the check and the remainder of the orchard, across the treated plots.

It will be noted that the first plot was treated with Bordeaux mixture, 3–3–50, with 1 pound of arsenate of lead added; the next plot was treated with hydrated lime, sulfur and arsenate of lead dust, 50–45–5; the next with lime-sulfur spray, 1 to 40; and the next with sulfur-arsenate of lead dust 90–10. Applications to all test plots were made first on May 31, 1919, after the petals had fallen; second on June 13; and third on July 19, just after the fruit picking. No dormant spray had been applied to any block of this orchard.

The advantages of the dust over the spray—from the standpoint of application—are evident in that the time of application alone, disregarding the time required for mixing, was more than double in the

case of the wet spray; also, in dusting one horse and two men required only half the time necessary in applying the wet spray with the aid of two horses and three men. The only disadvantage noted is that certain undesirable conditions of wind sometimes require a delay, and consequent loss of time.

Reference to the accompanying table shows very decided results secured by the application of all the treatments as compared with the check or untreated plot, but attention should be called to the counts of curculio damage in the check plot, which were much below the actual damage because of the previous falling of injured fruit; and it should be stated that the injury to treated plots, and consequent falling of fruit, was very slight. The records of curculio and slug damage were made from examination on June 19, just as the fruit was beginning to ripen. The examinations for leaf spot injury were made on September 19, three months later. Attention is called to the almost perfect control of slug and curculio on the treated plots as compared with the untreated plots. There was some brown rot apparent in the treated plots, but markedly less than in the checks.

Plot	No. of trees	Curculio		Leaf spot injury	Pear slug injury	
		No. infested cherries	No. cherries not infested			
Sulfur-lead dust 90–10	6	2	1240	None	None	
Lime-sulfur spray 1–40	5	8	1200	None	None	
Lime-sulfur-lead dust 50–45–5	5	1	1191	Slight	Slight	
Bordeaux spray 3–3–50 to 1 lb. lead	5	3	1536	Slight	Slight	
Check	8	444=29%	1071	Slight	No. slugs on trees 978	Leaves injured 23%

All Counts Made in Middle of Test Plots

Little falling of leaves, and scarcely any spotting, on treated plots was noted before the first week of September. Later on—September 19th—the falling of leaves on check plots was estimated at 60 to 65 per cent, and practically all the remaining foliage was badly spotted. On the treated plots, Bordeaux mixture showed at this date 30 to 40 per cent fall; lime, sulfur and arsenate of lead dust, 50–45–5, showed 35 to 45 per cent fall; lime-sulfur spray, 25 per cent spotted and little falling; while sulfur and arsenate of lead dust, 90–10, showed about 25 per cent spotting and no falling of leaves.

It is proposed to continue these experiments in the summer of 1920, but it would seem that conclusions from this summer's work would

favor the sulfur-arsenate of lead dust on account of the rapidity and ease of application and the high efficiency in control of curculio, slug and leaf spot.

MR. E. G. KELLY: Were the cherries counted only those infested with larvæ or also those punctured?

MR. J. G. SANDERS: Both larval infested and punctured were counted together in estimating percentage.

MR. O. I. SNAPP: I would like to ask Mr. Sanders if he experienced any difficulty in getting 90 per cent sulphur on the trees. In our experience in Mississippi, we have had some difficulty.

MR. J. G. SANDERS: We had no difficulty in completely surrounding and enshrouding the trees in a cloud of sulphur. In fact, it floated to four or five rows of trees in a very slight wind.

MR. O. I. SNAPP: I thought that the fact that so much sulphur was used would make it too heavy.

MR. J. G. SANDERS: We have never experienced any such trouble either in this case or in spraying or dusting peaches or apples. If you have sufficient power, you can project the dust to a very considerable distance.

MR. O. I. SNAPP: Did you use a Niagara machine?

MR. J. G. SANDERS: We used a Niagara outfit with a 3½ or 4 engine.

MR. E. G. KELLY: Were you using ground sulphur?

MR. J. G. SANDERS: The finest we could get.

MR. E. G. KELLY: Did the dew have any effect upon that?

MR. J. G. SANDERS: No.

MR. O. I. SNAPP: On what date did you spray?

MR. J. G. SANDERS: First on May 31st after the petals had fallen; second on June 13th; third on July 19th just after they had picked the fruit. The application on the 19th of July after picking the fruit was the one that was intended for the leaf spot control. It resulted in thorough control work, the leaves being retained on the trees as you saw in some of the photographs.

By vote of the Association the paper entitled "Distribution of the Oriental Moth," by H. T. Fernald, was read by the Secretary.

TEN YEARS OF THE ORIENTAL MOTH

By H. T. FERNALD, *Amherst, Mass.*

In January, 1907, a bulletin on the Oriental moth issued by the Massachusetts Experiment Station contained a map showing the approximate area then occupied by the insect. At that time the area was described as "very irregular in form, but as a whole extends farther

southwest from the probable center of infestation than in any other direction, and the longest distances in the territory are almost two miles in a northeast, southwest direction, by a mile and a half at right angles to this.

During the winter of 1916–17, through the kindness of Mr. L. H. Taylor, one of the deputy state nursery inspectors, this territory was scouted, with a view of learning how far the Oriental moth had spread in ten years. It was found that the territory then occupied by the insect, though still very irregular in outline, was nearly four miles in length, and nearly three miles in width at its widest point, and with an average width of nearly two miles.

The insect has now reached the ocean on the east and has extended its distribution farthest to the south and southeast from its center, though also somewhat to the north. It has hardly spread at all to the west, for some reason not at present apparent.

For a number of years the writer tried without success to obtain a parasite of the Oriental moth, which had been recorded as attacking it in China. Finally, through the kind assistance of M. l'Abbé J. de Joannis of Paris, the coöperation of M. Gaudissart of Tientsin, China, was obtained, and in 1917 shipments of parasitized cocoons of the Oriental moth were received, followed by others up to the present time. These parasites were bred out in the laboratory of the Massachusetts Agricultural College and liberated in the infested territory.

The small number of parasites received in the earlier shipments made the recovery of the insect doubtful even if it established itself, but later consignments in 1918 increased the chances of recovery, and a collection of Oriental moth cocoons made in the infested area in March, 1919, showed that about 6 per cent had been parasitized by the imported enemy. This is an encouraging showing.

The parasite is a Chrysid, *Chrysis shanghaiensis* Walk., a very representative member of the family, about half an inch long when adult. Apparently it does not attack the larvæ but is a pupal parasite, and herein has been the chief difficulty in colonizing it thus far, for the adult tends to emerge while its host is a larva about half-grown, and by the time pupation occurs, the weather is often so cold that the parasite becomes sluggish. Attempts will be made in 1920 to hold back the emergence of the parasites, by cold storage, until near the pupation time of the host, and then, if reasonably warm weather comes, the chances of a larger amount of parasitism should be greatly increased. Further studies on the life and habits of the Chrysis are now being carried on.

So far as the writer has been able to learn, this is the only case known where a Chrysis is parasitic on a lepidopteron, but no evidence has

thus far been obtained to support Sharp's suggestion that it is really parasitic on some hymenopterous parasite present, rather than on the Oriental moth itself.

By vote of the Association, an abstract of the paper by C. R. Crosby and R. G. Palmer, entitled "Some Results of the Special Spray Service Conducted in New York State," was presented by Dr. Felt.

THE ORGANIZATION OF A SPECIAL SPRAY SERVICE IN NEW YORK STATE

By C. R. Crosby and R. G. Palmer

It is becoming increasingly apparent that to be most effective demonstration work in the control of insect pests and plant diseases should be conducted for the most part on the basis of a seasonal program of treatment and not by demonstrating the control of any single disease or pest nor by isolated tests of spray materials or methods of application. The object of this kind of demonstration work is to show the value of the approved seasonal program of treatment as adapted to local conditions and to the weather prevalent during the season, and to teach the growers the most effective and economical method of protecting their crops from insect pests and plant diseases. Both from an educational and financial standpoint demonstrations conducted in accordance with the seasonal program are of greater value not only to the individual but also to the county as a whole. Efficiency requires that the work be done with an organized group of growers rather than with individuals. In order to achieve this result it is necessary that sound expert advice be available and that the necessary information be placed in the hands of the growers at the time when it will be of most use to them. In an attempt to meet these requirements we have in New York state worked out a plan of coöperation between the College of Agriculture and the County Farm Bureau Associations whereby a special field assistant is stationed in the county during the growing season and conducts the work under the supervision of the Departments of Entomology and Plant Pathology.

Our present system of conducting this work is based on the plan of organization and coöperation used during the war to increase crop production by preventing losses from diseases and insects. At the outbreak of the war the New York state legislature passed a law establishing a State Food Supply Commission for the purpose of stimulating production in agriculture. In coöperation with this commission, the College of Agriculture was enabled to conduct work in protecting crops from insect pests and plant diseases. In this work the Depart-

ments of Plant Pathology and Entomology coöperated in stationing special field assistants in certain counties to coöperate with the Farm Bureau Associations.

The plan of doing this work by means of field assistants was adopted because our experiences with industrial fellowships financed by associations of farmers had shown that the greatest good can be accomplished in the control of insect pests and plant diseases by having a trained man located in a definite territory where he can become thoroughly acquainted with the local problems, can watch the crops throughout the growing season and by his intimate knowledge of conditions be able to anticipate and prevent destructive outbreaks. He also is able to win the respect and confidence of the farmers as they become familiar with his aims and methods of work.

For field assistants, young men were selected who had had technical training in plant pathology and entomology and who, as far as possible, had had practical experience in the kind of agriculture with which they had to deal. They were placed only in counties where the local demand for their services was great enough so that the local farmers' organization was willing to furnish some means of transportation within the county—a motorcycle or automobile. These field assistants worked in close coöperation with the Farm Bureau manager and thus avoided duplication of effort and utilized the Farm Bureau organization for learning the needs of the county, for arranging demonstrations, and for assistance in reaching the individual farmers in each community.

The field assistants were under the constant supervision of experts thoroughly trained and of wide experience in demonstration work. These experts not only made sure that the advice given out was sound but also that the most efficient methods of disseminating such information were followed. The field assistant was in the field practically all the time, visiting the farmers and examining the crops and was thus often able to detect the presence of injurious insects while there was still time to fight them effectively. In the case of many of our pests it is impossible to control them after the injury becomes apparent. The development of many plant diseases is dependent on weather conditions; the field assistant was able to tell when infections were likely to take place and thus advise the proper preventive treatments.

In the season of 1917 field assistants were stationed in twelve counties. On the whole this work was so successful that in the season of 1918 the New York State Food Commission, successor of the New York State Food Supply Commission, set aside ten thousand dollars for the continuation of the work. Owing to war conditions it was impossible to obtain a sufficient number of competent field assistants and

the work was confined to a single county where highly satisfactory results were obtained.

In 1919 the Extension Department of the College of Agriculture adopted the policy of conducting the work of the field assistants on a more permanent basis. The college proposed to enter into a coöperative agreement with any county farm bureau association to station in the county a field assistant during the growing season, usually a period of six months. The college paid one hundred dollars a month towards the salary, additional salary to be furnished by the local association. The Farm Bureau furnished an automobile for the use of the assistant and paid his traveling expenses while in the county and away from headquarters. The assistant functioned as an assistant to the county agricultural agent but his activities were restricted to insect pest and plant disease control work and he was under the supervision of the college. Under this agreement field assistants were placed in six counties.

For field assistants, graduate students are selected. Our experiences, both with industrial fellowships and in the work with the Food Commissions, has shown that, in general, graduate students, preferably the younger ones, are more efficient and successful in this line of work than are older persons who have become more or less settled in life and consequently opinionated. It has been generally supposed that for this kind of work, mature men would be more desirable but as a matter of fact such is not the case. Where we have been compelled to use older men not actively interested in science or where we have used graduate students who were past the optimum age for study, we have had more misfits and failures than where younger men with more active interest have been employed. This may seem paradoxical. The explanation is that the salary available is not sufficient to attract mature men of sufficient ability. It is much better for the work to employ young men of special ability in their apprenticeship stage than men of mediocre ability who have nothing better in prospect. A young man who in the course of the next ten years is likely to be occupying a five to ten thousand dollar position is much more valuable for this work than an older man who would be satisfied to take a short term appointment at one hundred and fifty dollars a month. The younger men look on this work as an opportunity to obtain first-hand knowledge of field conditions and methods and are, therefore, willing to spend the summer season for two or three years in this way, since it is a part of their training and of direct advantage to them in their life work. Furthermore, they have an incentive to do their best since if they make good as field assistants they have a better chance to obtain a good position on receiving the advanced degree;

and, moreover, they do not receive a sufficient salary to make them wish to settle down in the work permanently as field assistants.

It has been found that the efficiency of the work requires that the field assistants be under the close supervision of some person well trained and who also has had experience in demonstration work. The supervisor should be a man of tact and enthusiasm who is able to help the assistants in becoming quickly oriented in their work, in getting in touch with the growers of the county, and in coördinating their activities with those of the county agricultural agent.

In those counties where fruit-growing is a highly specialized industry, the most important feature of the work is a spray service whereby the growers are kept informed as to the proper sprays to apply and the exact time at which they should be made. In most counties the information is sent to the growers by means of a relay telephone system, always supplemented by circular letters or postal cards. In some cases, where the time factor is not so important, the telephone is not used and the circular letter employed in its place.

In western New York, particularly, where the control of apple scab is of the utmost importance, the weather is the vital factor in determining the time at which most sprays must be applied. In this region the work of the field assistants was greatly facilitated by the coöperation of the United States Weather Bureau. A special forecaster was detailed to the Rochester office from April 6 to July 10. Arrangements were made whereby he received from Washington twice daily a special long range forecast, covering the conditions most needed by the service. These forecasts were often modified by the special forecaster. At least one of these forecasts as modified by the forecaster was sent daily to each of the Farm Bureau offices where a special assistant was stationed. As a rule the night forecast is more useful, but owing to the fact that the telegraph offices in the smaller towns are closed from 8 p. m. to 8 a. m. and the message cannot be delivered until after the growers have begun the day's work, it was found necessary in some counties to rely on the morning forecast.

In order to obviate this difficulty and also to facilitate the interpretation of the forecast, it has been found advantageous to have the general supervisor of the spray service in close touch with the special forecaster at critical times. Through a personal consultation with the forecaster he was often enabled to arrive at a decision in regard to a spray warning and immediately communicate with the field assistants of the various counties by telephone. In this way the assistant had knowledge of probable rainy periods three or four days in advance and was able to issue spray warnings in time for the growers to make the applications before the rains. A striking illustration of the prac-

tical value of these forecasts occurred on May 12, when the forecast indicated that a rain was probable in three or four days. Scab infections had already occurred in considerable numbers in orchards that had not received the delayed dormant spray. A spray warning was issued calling for the application of the blossom pink spray immediately although the blossoms did not yet show pink. The rain began in the afternoon of May 16. Subsequent events showed that this was the critical application for the commercial control of apple scab in western New York this season. In orchards where the application was delayed until after the rain of May 16–17, the leaves became badly infected with scab and a serious defoliation and fall of fruit resulted. Furthermore, in these orchards, it was very difficult to keep the fruit free from later infections. Had the special forecast of the Weather Bureau not been available, most of the growers would have waited until the 19th or 20th before making the application, when it was too late to protect the foliage.

In order to have a check on the accuracy of the recommendations made through the spray service, each assistant had certain demonstration or criterion orchards in which the spray was applied at the time advised. These orchards not only served to show the value of thorough and timely spraying, but also demonstrated the soundness of the advice given. They were of great educational value in teaching the necessity of having the fungicide on the trees before rainy periods.

In addition to the criterion demonstration orchards the assistant conducted fifteen or twenty demonstrations in the control of particular insects or diseases or in the use of spray materials or methods of application. Even in these demonstrations care was taken to have the work fit into a seasonal spraying program so that the results would not be obscured in the mind of the grower by the ravages of other pests or diseases.

In the fruit growing counties the assistant devoted all of the early part of the season to orchard work but later conducted demonstrations with potato growers. In one county the assistant devoted most of his time to the problems of onion growers.

For most effective work the number of demonstrations personally supervised by the assistant should not exceed twenty-five or thirty. The number of persons receiving the spray information service need not be limited but the assistant cannot be expected to visit all the men on such a list except in urgent cases and then only on special request. If he attempts to visit any very large number of growers the demonstrations and criterion orchards are sure to be neglected to the great detriment of the work.

The criterion demonstration orchards should be selected with care.

They should be distributed throughout the county so as to represent the different climatic zones and also serve as object lessons to the growers in different parts of the county. The differences in the seasonal development of the trees, owing to topographic and climatic factors, is much greater than is usually supposed, even in comparatively small areas. In Monroe County, for instance, a difference in the time of blossoming of from one to two weeks is not uncommon in orchards less than fifteen miles apart, on a gently sloping plain,—due in large measure to the retarding influence of the cold waters of Lake Ontario. The criterion orchard should be a representative commercial orchard consisting of the varieties commonly grown in the locality. It is important that the grower should be in sympathy with the work, that he be thorough-going and careful, and that he possess a modern and efficient spraying equipment. The arrangements for the criterion orchards are usually made by the field assistant with the advice and assistance of the county agricultural agent. Much of the success of the spray service depends on the results obtained in the criterion orchards, and too much care cannot be exercised in selecting energetic and congenial coöperators.

While special demonstrations, *e. g.*, tests of insecticides, methods of application, etc., are not so important, the rule still holds that the better the coöperator, the greater are the chances of the work being successful. In all cases the coöperator should agree to follow fully the directions of the field assistant and, where it would interfere with checking results, to leave at least a part of the crop unthinned. To determine the value of applications checks are desirable, but on account of the value of the crop it is not practicable to leave many trees untreated. Where the intent is to show the value of a seasonal system of spraying in comparison with no treatment, untreated trees are indispensable and should be selected with care. Where the demonstration is designed to show the different methods of control or the use of different materials, one part of the orchard can be checked against the other. In some cases, *e. g.*, pear psylla, checks cannot be left because of the danger of reinfestation from the untreated trees.

During the past season the six assistants we had in the field traveled an aggregate of 34,343 miles, making 3,017 visits, and issued 66 circular letters with a total circulation of 18,207. It is very difficult to estimate the financial return to the growers of the counties concerned, but there is every reason to believe that the increased value of the crops directly resulting from the work would pay several times over the entire cost of the undertaking including supervision and overhead. As an indication of the growers' appreciation of the work it may be stated that for next year twelve counties have requested to enter into a sim-

ilar coöperative agreement, in spite of the fact that for the coming season the college is able to pay only fifty, instead of one hundred dollars a month towards the salary of the field assistant.

PRESIDENT W. C. O'KANE: We will now take up the paper by Mr. E. D. Ball and F. A. Fenton.

WHAT PER CENT OF TIPBURN IS CAUSED BY THE POTATO LEAFHOPPER?

By E. D. BALL and F. A. FENTON

The senior author in 1919[1] pointed out that the potato leafhopper was responsible for a considerable part of the injury to potatoes which had previously been called tipburn, and suggested the name "hopperburn" for this specific effect. The authors of this article in their season's work in Iowa this year attempted to ascertain what was the relative proportion of the different factors in causing tipburn. Accordingly a number of fields of potatoes at Ames were kept under continuous observation during the entire season. The number of leafhoppers was recorded from day to day, as well as the relative percentage of nymphs and adults and their position on the vines.

It was found that there was no evidence of tipburn in the fields until after the over-wintering leafhoppers had appeared, laid eggs, and the generation of nymphs had begun to develop in numbers. The marginal burning then began to appear on the older leaves of the plant and extended observations in different fields showed that the amount of the burning was proportional to the number of leafhoppers present on the particular leaves affected, that in no case did burning develop in fields where no leafhoppers had appeared or on plants on which there were no leafhoppers, nor on the upper parts of the fast growing plants. The burning first appeared on the leaves at some distance from the top and gradually progressed upward as the plant developed and in about the same ratio as its growth for a considerable time. This was found to be correlated with the time required for the eggs deposited in the young shoots to incubate and the young nymphs to develop to an effective size. It was further found that as the burning progressed to the point where the plant was weakened and growth stunted, that it gradually approached the top until finally, at about the time growth ceased, the entire plant was affected and soon succumbed.

Careful counts were kept on a number of plants and each young nymph removed as soon as it hatched. In this way the average num-

[1] Jour. Econ. Ent. Vol. 12, p. 149, 1919, and Report of the Division of Entomology, Wisconsin Department of Agric. for 1917-19; p. 76, 1919.

1. Potato plant that had been protected from leafhoppers throughout season. Photographed at time of digging when all unprotected plants in the field were dead. 2. Potato plant that had been caged with large number of leafhoppers for three days. This plant was burned to a crisp. 3. Typical hopperburn injury to bean plant. 4. Portion of potato field showing type of cage used in experiments and enclosed hopperburned plant

ber of young that were produced on a hill was ascertained and was found to be about 2,000 for the second generation or about 10 million per acre. These results were obtained on typical fields where the average egg parasitism was about 40 per cent, so that the total number of eggs deposited per hill was above 3,000.

Potato plants inclosed in cages that excluded the leafhoppers from the beginning continued to grow with green and healthy foliage until digging time, when all the rest of the plants in the field were dead. Other plants in cages in which leafhoppers were introduced developed the typical burning of the vines in the field, showing that the green condition was not an effect of the cage. Twice during the season 250 or more adult leafhoppers were introduced into a cage at a single time with the result that all the leaves were burned and brown within three of four days. Plants in large cages, into which a small number of adult leafhoppers had been introduced, did not develop the burning until nymphs appeared.

To test the relative effect of the different stages of the insect, 50 adults of both sexes were introduced into a wire gauze cylinder on a potato tip, while 50 large nymphs were placed in another. In both cases burning developed, while the check cage remained green. In one test 50 males were placed in one cylinder and 50 females in another. The females produced serious burning while the males produced none. This was so striking that it was repeated with the same result. The males have so much less feeding capacity than the females that it is not safe to conclude from this single test that they are incapable of producing burning, but it does appear to show that they are not an important factor.

In a large cage a small number of adults were introduced. In another an equal number of small nymphs. After two weeks no burning had appeared with the adults while in the other cage here and there was a hopperburned leaf. In every case one or more large nymphs were found on the burned leaves, while there were none on the others. The reason why the adults produced no burning in this cage and did in the small cylinder was probably because in the latter they were confined to a small number of leaves while in the large cage they flew from leaf to leaf at will, while on the other hand the nymphs settled down on a single leaf and remained. The cylinder in which the 50 females had burned the tip was retained after the leafhoppers were released. Each day the young nymphs were removed as they hatched. Under this treatment new leaves were put out that remained green and healthy. This experiment was repeated, except that the nymphs were allowed to remain, with the result that the new growth burned in proportion to the growth of the nymphs.

To test the effect of humidity and partial shade, plants were inclosed in cloth (nainsook) cages. Under these conditions the plants remained without trace of hopperburn until the leafhoppers were added, when they developed this trouble as in other cases. Another experiment was carried on in a shaded greenhouse where potato slips were planted in moist sand. Burning developed on the leaves on which young nymphs were placed while those that were free from nymphs remained green and normal.

These observations and tests, as well as others carried on, by no means solve all the problems in connection with the relation of the leafhopper to the burned condition, but they appear to furnish conclusive evidence that the hopperburn can be produced at will by the use of the leafhoppers and prevented as effectively by their elimination. Tipburn has never been produced artificially in any other way and all the evidence points to the fact that its appearance in a field is strictly correlated with the attacks of the leafhopper. If these conclusions are warranted then "hopperburn" as a name for the leafhopper effect on potatoes covers practically all that has formerly been designated as tipburn on this plant. Tipburn has, however, been indiscriminately used for burning effects of all kinds on various plants, shrubs and trees and the substitution of the name "hopperburn" for the specific burning of the leaves caused by the potato leafhopper is justified in the interests of accuracy.

MR. G. G. BECKER: I would like to ask Dr. Ball whether in these experiments he noticed any correlation of the amount of curly dwarf and mosaic—anything that would confirm the work that was done in Maine some time ago.

MR. E. D. BALL: Curly dwarf and mosaic were not factors where we were carrying on those experiments.

MR. S. B. FRACKER: I would like to know whether the leafhoppers are as numerous as they were a year ago.

MR. E. D. BALL: The leafhoppers were even more numerous this fall than they were a year ago. With such a remarkably short fall, they did not have a chance to go into hibernation as nicely as usual and that may make a difference in next year's results.

MR. HIGH: How long did you leave the cages out in the field? What was the approximate date you put them out and the date you brought them in?

MR. E. D. BALL: The cages were out in the field from the time the potatoes were planted until they were harvested.

MR. HIGH: What time do you plant potatoes?

MR. E. D. BALL: About the 5th of May.

MR. LEONARD HASEMAN: What produces the injury of either tipburn or hopperburn or the curly leaf of beets?

MR. E. D. BALL: Those are two diseases that we know to be caused by insects and can be produced in no other way; but what produced them is a subject on which no pathologist or physiologist will even hazard a guess, so for a mere entomologist to make a suggestion would be far out of place.

MR. CROMWELL: I would like to ask what the comparative amount of leafburn was in 1919 and 1918 in Iowa.

MR. E. D. BALL: I was not in Iowa in 1918, except in the fall of the year, when it was approximately the same as during the fall of this year. It was a little worse during the hot period of the summer, I am told, in 1919. Our potato crop in Iowa this year was nearly a failure, more so than it was the year before.

MR. H. A. GOSSARD: I would like to ask Dr. Ball whether or not he ascertained to his satisfaction that the group of females were doing all the burning.

MR. E. D. BALL: That was a point that we were not able to determine. The handling of a very minute leafhopper like this proved to be one of the most difficult problems we had ever attacked. So much individual work was required that we did not have opportunity to carry these tests farther.

MR. W. O. HOLLISTER: You might be interested in a little experience I had with the leafhopper on the soy bean. I had some plants in the laboratory entirely free from any organism or insect. One leafhopper placed on the central stem of a plant produced an entire wilting and the leaf collapsed in fifteen minutes.

MR. J. R. PARKER: The control has not been discussed.

MR. E. D. BALL: Mr. Dudley's paper deals with that. I visited him this summer, and he told me that he used nicotine sprays and got almost complete control. I wish, however, that we might leave that until Professor Parrott's paper comes up.

Professor Dudley got control with tobacco solutions. I cannot give you the details, but his paper will undoubtedly give that when you have it. Professor Parrott obtained control with the Bordeaux solution. It is a fact that we had very much heavier infestations in Iowa.

PRESIDENT W. C. O'KANE: The next paper will be presented by Mr. W. E. Britton, on "A Connecticut Corn Field Injured by *Crambus præfectellus* Zinck."

A CONNECTICUT CORNFIELD INJURED BY CRAMBUS PRÆFECTELLUS ZINCK.

By W. E. Britton, *State Entomologist, New Haven, Conn.*

The cornfield in which this injury occurred is between one and one-half acres in extent, and is situated on Townsend Avenue, New Haven, only three or four miles from the center of the city. It was in grass in 1918, and was plowed in the spring of 1919 and planted to corn.

When only a few inches high, the plants began to look sickly and the outer leaves turned yellow, then shrivelled and died. The new leaves kept green for a time with the outer ones dead and brown, but the entire plant soon died.

At the base of each unthrifty plant a cavity or hole had been eaten into one side of the stem, often to its center. This injury was just at the surface of the ground or slightly above, and the grayish larva causing it was covered by a case formed of soil particles webbed together by silk threads, somewhat resembling small ant sheds. Apparently there was only one larva to each stalk, and when disturbed, the larva would quickly wriggle out of sight into crevices in the soil. Moreover the case or covering at first escaped notice because all of the plants were more or less spattered with dirt, and it was rather difficult to pull up a plant without losing the larva and its case.

On July 3, Mr. L. F. Harvey, county agricultural agent for New Haven County, first brought some of the injured plants to the Station laboratory.

Mr. M. P. Zappe, assistant entomologist, visited the field with Mr. Harvey the same afternoon and examined the plants and gathered more material. Later, on July 10, the writer visited the field. An occasional plant had escaped attack and was consequently much larger, darker green, and more vigorous than the other plants in the field. At that time there were many hills where all of the plants had been killed, and most of those remaining looked as if they would soon die. A few hills at the ends of the rows near the Avenue were not attacked and later I learned that these and occasional scattered stalks produced ears, probably less than a hundred all together, and the crop was almost a total failure.

At the time, this insect was supposed to be the corn web-worm *Crambus caliginosellus* Clem., a common species which injures corn in the middle and southern Atlantic states, and as all members of the force were busy with other work, no careful studies were made.

From the material gathered there emerged about September 1, four adults, which have since been identified at the Bureau of Entomology

as *Crambus præfectellus* Zinck., a native species which has not heretofore been recorded as injuring corn, though Mr. George G. Ainslie of the Bureau of Entomology, Cereal and Forage Crop Insect Investigations, stationed at Knoxville, Tenn., who has studied this and allied Pyralids, informs me that he has records of *præfectellus* being taken on corn in Florida, Arkansas and Tennessee, and on wheat in Indiana, but in no case was the injury of any extent or of any real importance. Prof. C. H. Fernald in *The Crambidæ of North America*, published in 1896, states that the early stages and food plants are unknown.

Mr. Ainslie states that there are few references in literature to this species, and most of them are systematic rather than economic. Apparently this is one of the first instances, perhaps the first, of any serious injury caused by this insect.

The larva is about 12 mm. long, 2.5 mm. thick, dirty white to ash-gray in color, rather prominently marked with darker tubercles. Each abdominal segment bears eight tubercles: six in a transverse row near the anterior margin of the segments, the outer two being below the spiracles; two transversely elongated ones, just back of the middle two, but more widely separated. Prothoracic shield whitish and shining, marked with several small dark gray spots; anal shield peppered with dark gray spots. Head whitish, shining, mottled dorsally with brown. Legs, prolegs and ventral surface, whitish. Each tubercle bears one or more hairs.

The adult is a Pyralid moth having a wing-expanse of from 20 to 24 mm.; forewings brown with a longitudinal white band extending from the base but narrowing to a point before reaching the subterminal. There is also a darker brown dash extending from the subterminal to the apex, and nearly bisecting the apical angle of the forewing, formed by white markings on each side. Terminal a darker brown line. There is a narrow, wavy, subterminal transverse line of darker brown whitish margined distally; between this line and the margin is a row of five small black elongated dots or short dashes. Fringe is light brown. Rear wings white, sometimes with a brownish tinge. Legs and antennæ light brown.

Adjournment.

Morning Session, Friday, January 2, 1920, at 10.00 a. m.

VICE-PRESIDENT A. G. RUGGLES: You will please come to order. The first paper will be presented on the "Work of *Empoasca mali* on Potato Foliage," by P. J. Parrott and R. D. Olmstead.

THE WORK OF EMPOASCA MALI ON POTATO FOLIAGE

By P. J. Parrott and R. D. Olmstead

Summary

This paper presented details of nine cage experiments and one field experiment to determine the effects of attacks of *Empoasca mali* LeBaron on potato foliage.

In all the experiments, feeding by the insects produced at first small brownish areas of one quarter of an inch or more in width at the tips and occasionally on the margins of the leaflets. The injury became more conspicuous as the season advanced, the brownish or burned areas increasing both in extent and numbers. The discoloration progressed from the tip towards the base of the leaf, and from the margins towards the midrib. As the tissues became desiccated the margins rolled up over the upper surface, leaving a small narrow strip of green tissue in the central area of the leaflet. In instances where such injuries were severe, all the leaflets curled and completely dried up, while the petioles often withered and dried so that any slight disturbance produced defoliation.

In the field test the planting comprised forty-two rows that were one hundred and eighty feet in length. The variety of potato grown was Enormous No. 9. The purpose of this experiment was to determine the repellent effects of the usual spraying mixtures upon leafhoppers as compared with mixtures of heavier consistency. Applications were made of the following preparations: (1), bordeaux mixture (10–10–100); (2), bordeaux mixture (10–10–100) with 6 pounds of paste lead arsenate; (3), china clay, 60 pounds to 100 gallons of water to which were added 10 pounds of soap; and (4), bordeaux mixture (8–8–100) with 60 pounds of lump lime. Four rows or more were sprayed with each mixture and two rows were reserved as checks. The applications were made with a power sprayer at a pressure of 100 to 150 pounds, and great care was exercised to cover thoroughly each plant, especially the under sides of the leaves. The first treatment was made on July 8. As rains had washed to a considerable extent the spraying materials from the foliage and the leafhoppers were invading the treated plats, a second application was made on July 16. Heavy rains occurred again within the next ten days, which necessitated a third treatment on July 28. The last application was made on August 25, which later developments indicated should have been made earlier and followed with another treatment two weeks later. Counts were made of adult leafhoppers at more or less regular intervals, which showed plainly that all the spraying mixtures had exerted considerable influence as repellents. Moreover, at no time during the season were the nymphs

abundant on the sprayed rows. Nevertheless, nymphs were observed on the vines, and during the latter part of August occasional burned tips were found on the sprayed plants, which was attributed to the unavoidable postponement of the fourth spraying. The marked feature of the test was that the check plants showed during August burned tips and margins of the leaflets, while in early September they rapidly declined. At this time the sprayed vines presented in the main luxuriant foliage with only slight traces of injury; while the checks, in striking contrast to them, were inferior in size and had scanty foliage, which was to a large extent badly shriveled and brownish in appearance. It should also be noted that several experts in plant diseases, who had followed with interest the various developments in this experiment, pronounced the injury to the checks as undistinguishable from the disease known as tip-burn.

The heavy washes, composed of china clay or lime, were a little more effective in repelling the insects than the other spraying mixtures. These sprays, in spite of their heavy consistency, caused very little trouble in clogging the nozzles, and produced a thick coating of the foliage. However, some objectionable features developed which should be noted. The china clay was more easily removed from the foliage by rains than any of the other mixtures, in spite of the fact that it was combined with soap, while lime caused injuries to the foliage. The damage was first noted on July 29 when the third application was made, and after this date the injury considerably increased. Because of the serious damage, the heavy limewash was the least satisfactory of the various mixtures that were tested. Although the bordeaux mixture alone or in combination with lead did not prove as effective a repellent as the sprays of heavier consistency, it should be emphasized that thorough spraying of all surfaces of the leaves of potato plants prevented serious damage by leafhoppers. Furthermore, this spray withstood the washing effects of the rains much better than china clay or lime, the combination with lead proving somewhat superior to bordeaux mixture alone.

MR. E. G. KELLY: In regard to Bordeaux-lime, do you make your Bordeaux and then add an excess of lime to it?

MR. P. J. PARROTT: Yes.

MR. E. G. KELLY: What is the effect on the Bordeaux?

MR. P. J. PARROTT: I am not able to answer your question, as we have not submitted samples of this combination to our chemists for analysis. In this particular planting we did not suffer from late blight, but I do not recommend the addition of large amounts of lime

for the spraying of potatoes, because of the danger of injury to the plants. However, with both apples and pears large amounts of lime may be applied with little fear of injury.

MR. LEROY CHILDS: In my experimental work I found sulphur dust could be used for control. I am wondering if any work with dust has been carried on.

MR. P. J. PARROTT: No.

MR. LEONARD HASEMAN: This work on potato leafhopper bears directly on one of our projects. I would like to ask Mr. Parrott whether in his opinion the burning is due to the sucking of sap or to the possible introduction of poison?

MR. P. J. PARROTT: My opinion is that with plant lice and insects of that character there is not only injury as a result of the extraction of the juices of the plant, but I think there is something in the salivary secretions of the insects which is toxic to plant tissues and thus accentuates the injury.

MR. E. D. BALL: I would like to raise one further question. We have a large number of sucking insects occurring on a large number of plants. It does not seem to make any difference what plant the potato leafhopper feeds on, whether a potato plant, a Dahlia, a box-elder, an apple tree or a raspberry bush, it always causes this burning. We have leafhoppers on practically every one of those plants, and none of them produce anything of the kind. The burning is limited to a specific insect. Further than that, the explanation is very largely yet to come.

VICE-PRESIDENT A. G. RUGGLES: The next paper is "The Strawberry Root Worm Injuring Roses in Greenhouses," by C. A. Weigel and E. L. Chambers.

THE STRAWBERRY ROOT-WORM INJURING ROSES IN GREENHOUSES

By C. A. WEIGEL and E. L. CHAMBERS

The immediate circumstances leading up to this investigation were the simultaneous reports received by the Bureau of Entomology concerning two widely separated infestations of an insect injuring roses in greenhouses at Alexandria, Virginia, and Richmond, Indiana. The specimens which accompanied these reports upon examination were found to be a chrysomelid beetle, the strawberry root-worm, *Paria canellus* Fab.[1] This pest though frequently reported as a serious enemy of strawberries, has hitherto not been reported as injurious to

[1] Fabricius, J. E., 1801, Syst. Eleut., p. 52, Vol. 2.

roses grown in greenhouses. It has, however, been recorded by Forbes[1] as being abundant on Juniper, *Juniperus communis*, and on the wild crab apple, *Pyrus coronaria*, as well as on the strawberry. It occurs less commonly on a considerable variety of plants both cultivated and wild.

A visit to the Alexandria infestation on July 25, 1919, revealed the seriousness of the report and appeal for assistance. It was found that the damage was being caused mainly by the adults, which were present in extremely large numbers. A total of eight large houses suffered infestation, five of the open range type being extremely heavily infested. Practically all of the foliage was badly perforated and ragged, presenting a shot-hole appearance as a result of the voracious feeding. The more or less rounded holes, varying in size and shape, were so close together that the plants looked as though loads of shot had been fired into the foliage at short range. In addition, a large proportion of the new and young shoots had the wood badly scarred and girdled, giving it a very unsightly appearance. It was found that the adults had a marked preference for this new wood, of which there was an abundance at this particular part of the season, owing to the fact that the roses were being forced. Further examination showed that the larvæ had also been feeding on the roots earlier in the season. As a result of all of these injuries a gradual killing of the affected parts ensued, causing a stunted growth of the plants.

The Indiana infestation was investigated by Mr. Harry F. Dietz, who at that time was still with the Bureau of Entomology and incidentally was in that vicinity. From his report it was obvious that the infestation was not as serious as that at Alexandria. In this particular case the injuries were confined for the most part to a ground bed of Killarney's growing in one of the five open range houses in which the insects occurred. These plants which had been forcing for about three weeks had put forth an abundance of young tender shoots. This was an analagous condition to that which existed at Alexandria. On authority of the florist it was learned that serious injury had been experienced during the month of May from this pest.

In an attempt at that time to control it they sprayed their roses several times with a mixture consisting of two pounds of powdered arsenate of lead and twelve teaspoonsful of paris green added to fifty gallons of water. This mixture, however, did not stick well and proved ineffective. A commercial brand of kerosene emulsion, diluted one part to sixteen parts of water was also tried. While it was found to kill the adults, it caused serious burning of the plants, the injury being still visible at the time of Mr. Dietz's visit five weeks later. Nico-

[1] Forbes, S. A., 1883, 12th Rept. of State Ent., Ill., pp. 150–177.

fume liquid at the rate of thirty-six teaspoonsful to four gallons of water was applied and found only to stupefy, but not to kill the adults.

On further inquiries at the Indiana State Entomologist's office we were informed that the strawberry root-worm was first recorded as a greenhouse pest in that state, November 8, 1916. The specimens of the insect and the report of the injury came from a florist at Cumberland. The Richmond infestation evidently started in 1915, according to the following information:

It was ascertained from the Richmond florist that this insect probably found its way into his greenhouses, three years before, in the larval stage in sod which was brought into the houses at that time. This sod was taken from soil in close proximity to their establishment on which large patches of wild strawberry plants were growing. These wild strawberry plants are also abundant at present on the right-of-way of the Pennsylvania railroad which runs directly by their infested houses.

A subsequent report indicated that it has been found attacking garden grown roses in the same vicinity.

In attempting to establish the possible origin of the infestation in Alexandria, records show that Mr. A. D. Borden had reported this insect as attacking roses in these same houses three years before. Recent evidence discloses that the soil in which the roses are now growing has been in these benches since then. We are, therefore, led to believe that the present occurrence dates back to that time.

Early in November the writers collected specimens of the strawberry root-worm in the rose house of the United States Botanical Garden at Washington, D. C., where they were doing serious injury. Since then, reports of its occurrence on roses have been received from Summit, N. J. In addition to this, E. N. Cory[1] in 1916, of Maryland Experiment Station, had occasion to work with it on roses in a florist's establishment at Baltimore.

A circular letter sent to all State Entomologists as well as other entomological workers has thus far failed to give us further records of its occurrence on roses, except the one record from Summit, N. J. This information was received from Dr. Peterson, the Assistant State Entomologist, substantiated by a report from the florist whose roses were infested.

Further information gathered from replies received indicates that it has been known to injure mountain ash, crab apple, and occasionally is reported as doing considerable damage in apple orchards. While primarily a pest of strawberries, its injuries to the above hosts are only occasionally of great consequence.

[1] Cory, E. N., 1916, Md. Agr. Soc. Rept., 1 p. 206.

History and Habits

The strawberry root-worm was first described by Fabricius[1] in 1801, under the name of *Cryptocephalus canellus* from a specimen in the collection of D. Bosc, recorded as collected in Carolina. Subsequently, and in recent economic accounts, this pest is commonly referred to under the name of *Typophorus canellus* Fab. According to Blatchley's classification, "to this genus belongs the species listed by Henshaw under the name of Paria." It appears as "Paria canellus Fab." in "Coleopterorum Catalogus" p. 156 by H. Clavareau (1914). The species is very variable in its coloration and many varieties are listed.

From the observation made at Alexandria, Va., as well as those from Richmond, Ind., it appears that this pest is single brooded, unless possibly an early generation may occur during the spring months of the year. At the time of our first visit (July 25, 1919) a copious number of adults were present, although several larvæ and pupæ were still to be found in the soil.

The florist in charge of the Richmond houses has observed the following habits: "In the spring throughout the first part of April the adults reappeared and about the middle of May and the first part of June do noticeable injury to the leaves."

Unfortunately, the authors were unable to make observations prior to the time at which it was called to their attention except as to injury displayed on the roots. The adults are rarely seen and have never been observed feeding during the brighter hours of the day. Occasionally they may be collected in dead or dried and curled up leaves or under débris, etc., among the surface soil. Beginning at dusk and extending to the early morning hours they may readily be observed feeding on the plants. On being disturbed they play possum or feign death.

Observations at the Alexandria houses on the varieties most seriously attacked showed the beetles displayed a fondness for the Sunburst, Red Radiance, Killarney and Ophelia, of which the first named suffered most severely. At Richmond, the Premier and Ophelia seemed to be most heavily injured, with the Columbia, Victor, Hoosier Beauty and Killarney in the order named.

Experiments on Control

Inasmuch as a serious infestation existed in the above-named greenhouses, the entire crop of roses was threatened, because the ravages of the insects were progressing at such an alarming rate. Moreover, roses at this season of the year were being forced as the weather conditions were very favorable. Therefore a delicate situation presented

[1] Loc. cit.

itself, and necessarily the program of control would have to be in accordance with the cultural methods, so as not to prove deleterious to the future growth of the plants.

Ordinarily arsenicals are the standard remedies used to combat such ravenous leaf feeders. Hence, it was decided to make a few preliminary tests of varying strengths of paris green, calcium arsenate, and arsenate of lead. It was found that powdered arsenate of lead did not injure the roses when used at the rate of two to two and a half pounds to fifty gallons of water, adding one-half ounce of soap to each gallon of spray material. All of the infested plants were, therefore, thoroughly sprayed with the above insecticide, using a pressure sprayer. Special care was taken to cover all the foliage so that it presented a white-washed appearance which was retained for many days. Contrary to the general reported control on strawberries with arsenicals, it was soon found, however, that under the existing conditions such measures were ineffective. This was due to the particular choice which the adults showed for the young and tender growth that was being forced, during the hot sultry nights, and which in turn could not be sprayed constantly in order to keep it covered with arsenate of lead. This was coupled with the insects' nocturnal feeding habit. Further, it was found that they practically avoided the lead covered foliage. This naturally necessitated an immediate change of the control program because of the alarming rate at which the injury was proceeding.

The next consideration, therefore, was the use of a standard fumigant such as hydrocyanic-acid gas which is frequently employed in greenhouse fumigation. Here again, we were confronted by the question of determining a killing dosage for the adult beetles, of which very little was known. Secondly, the advisability of using such measures on the tender growth.

Preliminary experiments with a fourth to half an ounce of sodium cyanide per thousand cubic feet of space proved entirely ineffective. The maximum dosage which roses are known to withstand, using two ounces per thousand cubic feet of space was therefore employed. The exposure lasted two hours. It is advisable to point out the fact that fumigation at this strength and duration during hot sultry summer nights is contrary to the general recommendations for fumigating greenhouses, but drastic measures were imperative, otherwise the whole crop might just as well have been left to the insects for complete destruction which most certainly would have followed.

An examination of the fumigated houses at 8:30 o'clock the following morning showed very encouraging results. The beetles were found lying on their backs, or sides, exposed on the surfaces of the foliage in great numbers. Many were killed in their tracks in the act of feeding,

while others could be found lying on the surface of the bench soil and beneath the plants. Owing to the fact that the adults showed a marked tendency to feign death, a total of 317 of the apparently dead insects were collected and held in cages for several days for further observations. Of these less than 3 per cent revived from the effects of the gas, or expressed in other words a killing of 97 per cent of the adult beetles resulted from the above fumigation.

As was anticipated practically all of the tender growth was more or less burned. This injury, however, was only temporary since at the expiration of three weeks the plants were in excellent condition and had produced an abundance of newly forced growth which was attributed to the stimulating effects generally following fumigation with hydrocyanic-acid gas. Incidentally the burning back of this young growth deprived the few remaining adults of their favorite place of feeding.

From the above experiments it appears that until further progress has been made in life history studies and habits of this new rose pest in greenhouses, a satisfactory method of controlling the adults of the strawberry root-worm is by the use of hydrocyanic-acid gas, at the rate of two ounces sodium cyanid per one thousand cubic feet of space, with an exposure of two hours. The destruction of the adults at this time should forestall a recurrence the following spring and summer, since a very large percentage of the adult females are killed many months prior to the normal time of egg laying.

MR. ALVAH PETERSON: This insect has been very injurious in a large rose-house at Summit, N. J., for three seasons. For two seasons we have been making more or less careful studies on the life history and control measure. We have found at least two generations during the year, the adults appearing in large numbers during the months of June and July, and again in September. At this time of the year (December) you will find the form in the soil passing the winter in the adult stage. About the first of February, the adults come out, feed and then deposit their eggs. They continue to deposit eggs until about the last of April, and a little later young larvæ are found in the ground about the base of the rose plants. Full grown larvæ and pupæ are abundant early in June. The adults make their appearance in considerable numbers in June and July. During August the adults are greatly reduced in numbers. Again in September full grown larvæ and pupæ may be found in the soil and the pupæ change into adults. So far as observed all of the adults come out and feed before going into a dormant condition.

In respect to control measures, we have tried soil treatments, fumigations and sprays. As yet, we are not satisfied with any of the results. Hydrocyanic acid gas was used in August at the rate of one and one-half ounces for twenty minutes. A very serious burning of the foliage and young growth occurred and only a small per cent of the adults were killed. The burned plants were set back to such an extent that they did not fully recover that season. Dusting with a lead, sulfur and lime mixture when the plants are in the drought period (June and July) gives considerable promise for control.

At the present time, Mr. May, who is the owner of this greenhouse, employs a beating method. When the adults are abundant in the morning, he puts his force to work beating the bushes. The men hold pans under the bushes and catch the adults as they fall. When the bushes are jarred, the adults will fall from them. This seems to be a very crude and an expensive method. The adults have been caught in large numbers and the infestation has been reduced to such an extent that this past season the injury produced by the adults was by no means as serious as in previous seasons.

PRESIDENT W. C. O'KANE: The next paper on the program is "Poison Baits for Grasshoppers," by W. P. Flint.

POISON BAITS FOR GRASSHOPPERS

By W. P. FLINT, *Urbana, Ill.*

Under Illinois conditions at least 75 per cent of the damage by grasshoppers occurs in fields of clover, alfalfa, soy beans, cowpeas, and other legumes. This is not due so much to the fact that the hoppers hatch from eggs deposited in such fields as that they congregate in them during the summer. It would seem that under our conditions legumes are distinctly attractive to grasshoppers and it was thought that a poison bait with a strong legume odor might possibly prove more attractive than the standard bran-molasses-lemons bait. So far as known to the writer, no tests with such mixtures have been made, with the exception of the alfalfa meal mixture which has been used to some extent in the west and very little in the states east of the Mississippi. The odor from the alfalfa meal, however, differs from that of freshly ground legumes, and has not been found particularly attractive to grasshoppers. To test the effect of adding freshly ground legumes a series of experiments was carried out, using the standard bran bait in comparison with a bran-Paris green bait containing the same amount of poison, but in which a certain amount of freshly ground legumes had been mixed.

The inner bark of the black locust, *Robinia pseudacacia*, has the strongest characteristic legume odor to be found in any plant known to

the writer. For this reason it was selected as the substance to be used in the first test with these baits. Of course, this bark could not be obtained in sufficient quantities to make practical its general use for this purpose. Twenty-five pounds of bran and one pound of Paris green were mixed dry, and a stiff mash was made by adding water in which had been stirred about one-half pound of the ground inner bark of the black locust. The generally recommended bait, consisting of 25 pounds bran, one pound Paris green, two quarts molasses, six lemons and water sufficient to make a stiff mash, was mixed at the same time, and the two baits applied at the rate of about 10 pounds to the acre in a clover field where the hoppers averaged about 25 per square yard. The baits were sown early in the morning, and counts of the dead hoppers in five square yards made in the afternoon of the next day. The results of the test with this material showed nearly as many grasshoppers killed where the legume was used instead of the molasses and lemons. As the locust bark was difficult to obtain and also hard to grind, three pounds of freshly ground green beans were substituted in subsequent tests.

During 1918 and 1919 seven tests were made, using the standard bran mash, and in comparison, the same amount of bran and Paris green mixed with water containing three pounds of finely ground green beans. In all but one of these tests a considerably higher number of grasshoppers were killed where the beans were used, as was shown by counts of the dead hoppers found by carefully examining five square yards of the treated clover fields the second afternoon after the baits had been sown. Counts made in this manner in 45 square yards of treated clover showed an average of two dead hoppers per square yard more in the areas treated with green beans than in those where the standard poison bran bait had been used. This is not a very much higher kill, but seems to prove rather conclusively that this bait is at least as good as the standard mixture. With the present price of materials for making these baits, it will cost about 25 cents per acre less to treat with the legume bait than with the molasses and lemons. This bait has the added advantage that the materials for making it are nearly always at hand.

During the summer of 1919 several experiments were tried in which three pounds of freshly ground clover were substituted for the ground green beans. The results of these tests showed that the bait made in this manner was practically as good as that made with the beans, and was a little better than the bran-molasses-lemons bait. Recent work of Dr. Morrill in Arizona[1] seems to show that the bran bait without the addition of either molasses or lemons is nearly, or quite, as effective as

[1] Jour. of Econ. Ent., Vol. 12, p. 337.

the bait where these materials are used, and it is possible that the use of legumes has not added very greatly to the attractiveness of the bait in the experiments just reported. However, no work was done which would give a comparison with bran, Paris green and water alone. The eight tests reported seem to show conclusively that the addition of the ground legumes to the water used in mixing the bran and Paris green bait renders it fully as attractive as does the addition of molasses and ground fruits, in the quantities usually recommended.

The following table shows the number of dead grasshoppers found in five square yards, on examining the fields where the different baits had been applied.

There are certain situations in which it is not desirable to use the poison bran baits. Some of these are roadsides, ditch banks, and like places, covered with a growth of large tall weeds; gardens and truck patches in the vicinity of dwelling houses, where the owner may not wish to use the bran bait for fear of killing chickens or wild birds; although there seems to be very little, if any, evidence to show that birds are ever poisoned by this mixture. Several years ago the writer noticed the fact that grasshoppers feed readily upon paper, especially the heavy brown wrapping paper such as is generally used in stores for wrapping heavy parcels. It seemed that it might be possible to treat papers with a poisonous solution to which some substance attractive to grasshoppers had been added, and that such papers if fed upon by the hoppers would prove effective in killing them. It was thought at first that the soluble poisons would be best to use in this way, and that papers soaked in such solutions would probably absorb sufficient poison to render them effective in killing the grasshoppers should they feed upon them. A few tests with papers soaked in solutions of one gallon of molasses, two pounds of sodium arsenite and 32 gallons of water failed to kill any grasshoppers, although the insects fed upon the papers in large numbers, and continued to feed upon them for several days. A solution was made in the same proportions, but substituting for sodium arsenite, crude arsenic containing about 10 per cent water soluble arsenic. A few grasshoppers were killed by feeding on papers soaked in this solution, although this was not nearly as effective as the standard poison bran mash. As the grasshoppers fed readily upon the papers, and still but poor results were obtained as far as actual number killed was concerned, it was thought possible that an insoluble poison would increase the effectiveness of this method of treatment. Consequently an experiment was tried using Paris green in place of the more highly water soluble poisons. In these experiments several old newspapers were torn into pieces about four inches square, and soaked for one-half hour in a mixture of one gallon water, one-fourth cup molasses,

TABLE I. NUMBER OF DEAD GRASSHOPPERS FOUND IN FIVE SQUARE YARDS

SPRINGFIELD, 1918

	25 lb. bran 1 lb. Paris green 2 qt. molasses 6 lemons water	25 lb. bran 1 lb. Paris green 6 lemons water	25 lb. bran 1 lb. Paris green 2 qt. molasses water	20 lb. bran 1 lb. calcium arsenate 2 qt. molasses 6 lemons water	25 lb. bran 1 lb. Paris green 3 lb. ground green beans water
Sown July 17 Counted July 18	106	89		76	94*
Sown July 30 Counted Aug. 1	152		139		171
Sown Aug. 1 Counted Aug. 3	129		75		165

URBANA, 1919

	25 lb. bran 1 lb. Paris green 3 lb. ground green cornstalk water	25 lb. bran 1 lb. Paris green 3 lb. ground clover water	25 lb. bran 1 lb. Paris green 3 lb. ground green beans water	25 lb. bran 1 lb. Paris green 2 qt. molasses 6 lemons water	25 lb. bran 1 lb. crude arsenic 2 qt. molasses 6 lemons water
Sown July 18 Clover Stubble Counted July 19			32	9	10
Sown July 23 Counted July 25	25		25	19	10
Sown July 25 6" Clover Counted July 26	21		48	41	32
Sown July 28 Hard Rain Counted July 30	1	29	11 (Mash Sour)	27	20
Sown Aug. 2 Counted Aug. 4	21	29	34	26	17
Sown Aug. 6 Counted Aug. 7		135		151	

*Ground inner bark of black locust was used instead of ground green beans.

two ounces Paris green and one ounce salt. These papers were sown between 5:00 and 6:00 a. m. over a clover field containing about 25 grasshoppers to the square yard. An adjoining strip in the same field was treated with the standard poison bran mash at the rate of about 10 pounds per acre. The papers were sown as evenly as possible over the field in such a manner as to leave the bits of paper about six inches apart. Counts made the second day from the time of application showed nearly four times as many dead hoppers per square yard in the area where the papers had been used as in that sown with the poison bran mash. At this time grasshoppers were still feeding in considerable numbers upon the papers, although they fed very little upon the poison bran except during the first few hours after it was applied. In fact, several later visits to this field showed that the hoppers continued to feed upon the poisoned papers until they were almost entirely consumed. The results of two other tests conducted in the same manner showed a much higher number of grasshoppers killed in parts of the field where the poisoned papers were scattered than in that treated with the poison bran mash.

While sufficient tests have not been carried out to prove that greater numbers of grasshoppers can be killed by the use of poisoned papers than with the poison bran bait, it seems advisable to mention this method, as it has several distinct advantages. If later experimental work proves that such a method is more, or equally, effective, the preparation of such papers might be taken up by some of the insecticide companies. It seems that such a paper could be manufactured, containing the poison and some substance rendering it attractive to the grasshoppers, and could be sold in bulk. To prepare it for use one would merely have to soak this paper in water and distribute it on the infested fields. Such a material could probably be sold much cheaper than the homemade poison bran mash could be prepared, and if distributed through the usual trade channels, would be used more readily by the average farmer than is the case where he has to mix the materials himself.

MR. STEWART LOCKWOOD: I would like to ask if any count was kept of the grasshoppers feeding on the poisoned paper when it was damp and when it was dry. Did they eat more of the damp paper than of the dry paper?

MR. W. P. FLINT: The papers seem to work in much the same manner as the bran. When the paper was distributed it was damp and the grasshoppers came to it from quite a distance, although quite a few were found feeding on the paper in mid-afternoon of a bright day when it was thoroughly dried up.

MR. T. J. HEADLEE: Is there danger of cows, chickens, etc., eating poisoned paper?

MR. W. P. FLINT: I do not know that there is any greater danger in using the paper than in using poisoned bran. I was, however, able to overcome the prejudice with some people by using paper instead of bran.

MR. J. R. PARKER: At the Montana Experiment Station this past summer we conducted preliminary experiments with twelve different attractive substances and much to our surprise found that lemons and lemon extract ranked at the bottom of the list and that amyl acetate was far ahead of any of the others; we also found that salt alone was practically as good as when both molasses and fruit juices were used.

MR. ARTHUR GIBSON: In our work in Eastern Canada, we have conducted a large number of experiments in controlling locusts and like Mr. Parker, we have found that salt is one of the best attractants. We used the ordinary Kansas bait in 1915 at the cost of 21 cents an acre. Substituting salt for the molasses and fruits we reduced the cost to 7 cents an acre. One of the best formulas we used was 20 pounds of sawdust, one-half pound Paris green, one-fourth pound salt, and three gallons of water. We have killed, with this mixture, up to 720 locusts to the square yard.

PRESIDENT W. C. O'KANE: The next paper is entitled "Organization for Grasshopper Control," by George A. Dean and E. G. Kelly.

ORGANIZATION FOR GRASSHOPPER CONTROL

By GEORGE A DEAN, *Entomologist, Kansas State Agricultural College and Experiment Station*
and
E. G. KELLY, *Extension Entomologist, Kansas State Agricultural College*[1]

Since the first recorded devastation in Kansas, western Kansas has been the scene of several outbreaks of grasshoppers. Inasmuch, however, as several other western and some eastern states have records of devastation by this pest, Kansas cannot claim the distinction of being the "Grasshopper State," although it has been so dubbed by many people. The state has a large acreage of level prairie lands suitable for cultivation and in proportion to its area probably has almost as large an acreage under cultivation as any other state. In spite of the fact that there is very little waste land on farms, the roadsides and fence-rows afford abundant breeding grounds for grasshoppers. Western Kansas grows a large acreage of wheat, oats, barley, alfalfa, corn

[1] Contribution No. 50, from the Entomological Laboratory, Kansas State Agricultural College.

and sorghum, and at one season or another these crops are all subject to attack. Wheat is often attacked in the fall, the hoppers coming in from the edges and roadsides, and devastating a strip of the young wheat from two to four rods wide. In cases of bad outbreaks, such as the one in the fall of 1918, entire fields are devastated by the lesser migratory grasshopper, *Melanoplus atlanis*. In the summer oats, barley, alfalfa and corn are frequently damaged by the hoppers concentrating soon after leaving the ripened wheat. Sorghum, except when very small, is not readily attacked.

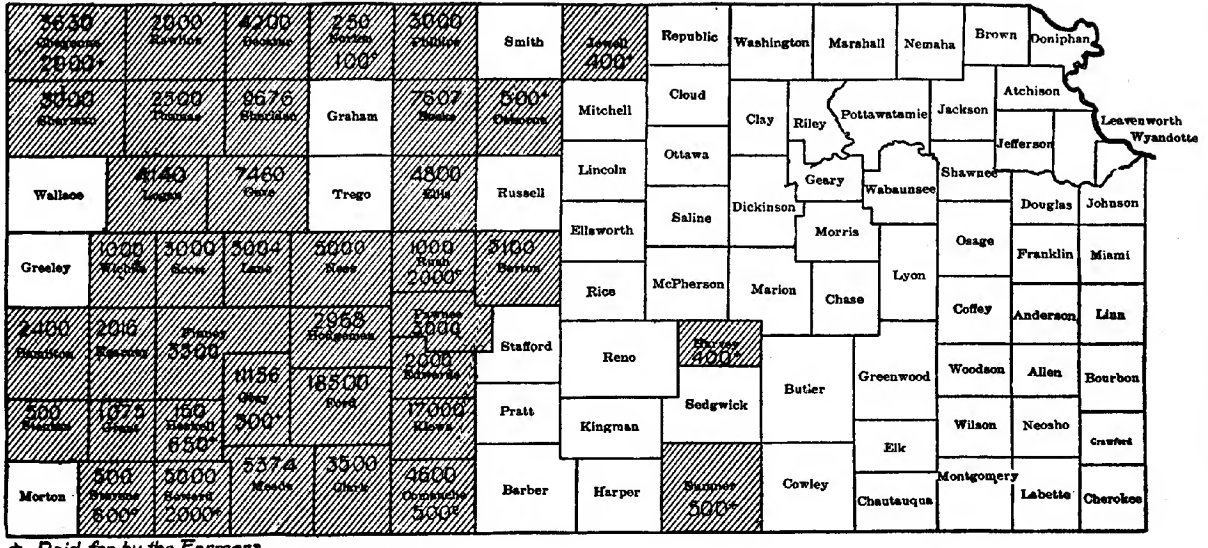
In the fall of 1918, thousands of acres of fall sown wheat were devastated by the grasshoppers and millions of eggs were deposited in the favorite places, especially in wheat planted on fallow land and in corn land. Many miles of roadside and fence-rows were burned and disked, destroying myriads of eggs, and had all the farmers practiced this method of control there probably would have been no serious infestation in 1919. The several miles of disked roadsides and fence-rows amounted to a small percentage compared to the thousands of miles not disked. Early in May the grasshopper eggs began to hatch, and by June 1 the roadsides and fence-rows were literally swarming with young hoppers. A general warning was sent out calling attention to the seriousness of the situation, and a few farmers who realized the danger put out the poisoned bran mash. Three counties even organized for concerted action, but still the farmers went about the work with an indifferent attitude, believing the hoppers would do no damage to the wheat or other crops.

In early June farmers were surprised to find so many hoppers scattered over the wheat fields, instead of along the edges only as in previous years. Investigation soon showed that the fields in which the hoppers were so plentiful were either fallowed or fields following corn. Since these fields were in good condition of tilth they were not even so much as disked or harrowed before planting, and thus the hoppers found a hard surface in which to deposit their eggs. It was in these fields that they were found in early June and not in those which had been recently cultivated before seeding. It was also these fields that later suffered devastation. Although the grasshoppers were in the wheat, oats, and barley in much larger numbers than the farmers expected, yet they had always had grasshoppers in these crops and had managed to harvest a crop. This year, however, the hoppers won out. The hot days in late June following a wet period ripened the wheat very rapidly. The hoppers had eaten most of the leaves and those left dried quickly in the hot sun. The grasshoppers in search of food simply crawled up the stalks where they found a bit of green just below the head. Here they ate an elongated notch into the stem. Right at

this time there came an unusually hot Saturday, followed by a brisk wind on Sunday, and when the sun set on that memorable day, June 29, Kansas had lost millions of bushels of wheat which was literally strewn on the ground. The wheat fields had the appearance of having been cut with a dull header. There were several counties in Kansas and Oklahoma injured in this manner. An official estimate of loss in one county (Ford County) was one and one-half million bushels of grain, or more than three million dollars. Since the sudden ripening of wheat precipitated the hoppers into the oats and barley which were still green, another big loss was caused, and corn, alfalfa and sorghum were threatened. In the stricken counties the situation was recognized as alarming, and a hurry-up call for assistance came to the college. On July 15 a special conference of county agents was called at Dodge City. Twelve county agents from Kansas and two from Oklahoma met with Karl Knaus, County Agent Leader, and E. G. Kelly, Extension Entomologist, for the purpose of drawing up plans for immediate action. The Kansas grasshopper law[1] made it possible for very quick action. According to the law, upon receiving "a written request signed by not less than five township trustees of any county, or by a majority of the township trustees in counties having less than five townships in this state, the board of commissioners of that county shall provide for the purchase of a mixture containing Paris green, or other like poison, for the extermination of grasshoppers within its county, and shall make rules and regulations for the distribution and use thereof, and shall distribute the ingredients of such mixture to the township trustees of the various townships which may require the use of such mixture for the extermination of grasshoppers in their respective townships. In purchasing and preparing the ingredients of such mixture, the board of county commissioners and trustees of such township shall use the formula prescribed and recommended by the Kansas State Agricultural College or its experimental stations as far as practicable."

There were 28 counties in Kansas, and four in Oklahoma in which immediate action was to be taken. The arsenic, lemons, syrup and bran needed were estimated. Telegrams went out to dealers for information on supplies and quotations. By 6 p. m., July 16, the supplies were located and quotations furnished. A carload of white arsenic en route to a Kansas City commission firm from Utah was rerouted for Dodge City at Denver, Colorado. This was indeed fortunate for arsenic was the one article most needed and most difficult to procure. The other ingredients were closer at hand and readily accessible.

[1] Chapter 147, Session laws of 1917, as amended by House Bill No. 159, Session Laws of 1919.



+ Paid for by the Farmers
○ Paris green.

Fig. 6. Number of pounds of white arsenic or Paris green used in the grasshopper campaign of 1919. (Unless otherwise indicated, the poison was furnished by the county.)

The second and most important step was organizing the forces in each county for effective work. Each county agent readily handled his county through the farm bureau. The counties without county agents were organized by representatives of the college during the following eight days. The method of organizing the county was to have the township trustees request a meeting of the county commissioners at which time they not only presented the petition to the county commissioners, but also made an estimate of the amount of material their respective townships would need. The commissioners acted at once and placed an order for the material. The township trustees were responsible not only for the equitable distribution of the material for making the poisoned bran mash, but also for seeing that no one shirked his duty.

The northwest counties did not suffer loss to wheat but as soon as the wheat was cut the grasshoppers began migrating to corn, barley, alfalfa and sorghum. Ten of these counties coming under the jurisdiction of one district agent were organized by him with the assistance of two representatives from the college.

The coöperation of the farmers, county commissioners, and township trustees was such that many thousand acres of crops were saved from devastation and millions of grasshoppers killed.

The total number of counties organized was 39, representing an area of 33,985 square miles, or about two-fifths the entire area of the state. The total amount of bran mash distributed was 4,565 tons, or 183 carloads. This required 83 tons of white arsenic, 498,000 lemons, and 83,000 gallons of syrup.

In addition to the above amount of white arsenic, 20 tons more were ordered to be used in the fall in case the situation warranted it.

The results of the poisoning campaign were excellent throughout the infested areas. Very few reports of poor results were received, and in practically every case these were due to improper mixing and applying. It should also be borne in mind that poisoning the grasshoppers at this time also protected the fall wheat, for no reports of injury to this crop have reached the office this fall.

MR. STEWART LOCKWOOD: I would like to ask Mr. Dean to go a little more thoroughly into his organization of the county and township. When the material was received, how was it handled to get it out directly to the farmers?

MR. G. A. DEAN: For a number of years we have been using poison bran mash in Kansas, and thus a majority of the township trustees are thoroughly familiar with the method of distributing it. In many cases, when the county commissioners receive the materials, they

turn them over to the township trustees, who have previously estimated the amount they will need in their townships and who are held responsible for the work. The farmers come to their township trustees for their materials. In other cases, the farmers all come to the county seat where the materials are checked out by the commissioners, or the county farm agent. If the township trustee is not familiar with the proper method of preparing the poison bait and distributing it, either the county agent, or a person from the college will spend a day with him in order to demonstrate the proper method of mixing and distributing. As a matter of fact, since the bran mash has been used very extensively for several years, nearly all of the farmers are thoroughly acquainted with the work, and need no assistance except in organizing for concerted action.

MR. STEWART LOCKWOOD: It might be of some interest to know that in North Dakota we have put on a campaign along similar lines. We have been forced to use 6,600 tons of bran and about 540,000 pounds of arsenate with the ingredients to go with it. We haven't had time to experiment with different formulas, but we have taken the Kansas formula with the exception of adding four pounds of salt to the arsenic, and we have advised the farmers in every case to ferment their mixture, that is, to keep it in a barrel or sack that is damp twenty-four or forty-eight hours before it was spread. We will say that up there in North Dakota the poison bran mash that had been fermented gave much more satisfactory results than the other.

PRESIDENT W. C. O'KANE: Mr. J. W. McColloch will present the next paper, "A Study of the Oviposition of the Corn Earworm with Relation to Certain Phases of the Life Economy and Measures of Control."

A STUDY OF THE OVIPOSITION OF THE CORN EARWORM WITH RELATION TO CERTAIN PHASES OF THE LIFE ECONOMY AND MEASURES OF CONTROL[1]

By JAMES W. MCCOLLOCH, *Associate Entomologist, Agricultural Experiment Station, Kansas State Agricultural College*

In 1908 the Department of Entomology of the Kansas Agricultural Experiment Station undertook a complete study of the corn earworm (*Chloridea obsoleta* Fabr.) with relation to its injury to corn in Kansas. These studies had been in progress but a short time when it became apparent that a thorough investigation of oviposition in the field would furnish much valuable information relative to many points in the life

[1] Contribution No. 43 from the Entomological Laboratory, Kansas State Agricultural College. This paper embodies some of the results obtained in the prosecution of project No. 9 of the Agricultural Experiment Station.

cycle and towards the development of certain methods of control. Accordingly, during 1908 and 1909 general egg counts were made at irregular intervals in the field, and the results of these counts with relation to the number of broods and to the time of planting corn have been discussed by Headlee.[1] These preliminary studies were of such significance that in 1913 further experiments were planned to determine more accurately the relation existing between oviposition and various phases of the life history and methods of control.

These experiments were incorporated in "a time of planting experiment of corn" which has been in progress since 1909. Briefly, the major problems under consideration were to determine (1) the number of broods in the field, (2) the part of the corn plant selected for oviposition, (3) the relation of oviposition to the time of planting corn, and (4) the relation of oviposition to the variety of corn.

Experimental Methods

Time of Planting Experiment

In order to better understand the data presented in this paper, a brief discussion of the time of planting experiment is essential. This investigation has consisted of a series of five or six plots of corn planted at regular intervals beginning April 15. Four standard varieties of corn, namely, Boone County White, Commercial White, Kansas Sunflower, and Hildreth, have been grown in each plot, each variety being planted in three 200-feet rows. Plantings were made on April 15, May 1, May 15, June 1, and June 15. In 1914 and 1915 a sixth plot was planted on July 1, but since corn seeded at this time seldom if ever matures, this plot was discontinued. Since 1913 this experiment has been conducted on the same area and the land has been handled in the same manner as is usually followed by the average farmer. The rows were forty inches apart and the hills thirty-six inches. Shortly after coming up, the corn was thinned to two plants in a hill.

Method of Making Egg Counts

The egg counts were made on the same plants throughout the entire season. A typical plant of each variety in each plot was selected when it was about six inches high, and was examined daily for eggs of the corn earworm. These plants were selected through the center of the plots and were in the middle row of each variety.

Silking

As earlier studies at this station and in other localities had shown that the earworm moths apparently preferred the silks of corn and

[1] Headlee, T. J., Notes on the Corn Earworm. In Jour. of Econ. Ent., Vol. 3, No. 2, pp. 149–157, 4 charts. 1910.

corn plants that were in silk, it seemed advisable to follow the silking of the different varieties in each plot to determine the relation existing between silking and oviposition. Accordingly, in 1913, a detail study of silking was undertaken. The number of ears bearing fresh or attractive silks were counted each day on the middle row of each variety in each plot, a silk being considered attractive from the time it appeared until it became dry.

Climatic Data

Climatological conditions, especially rainfall, have a direct bearing on the growth of the corn plant and also to some extent on the corn earworm. In order to properly interpret the data presented in this paper, the essential records of rainfall are shown in Table I. It usually follows in the area under consideration that the various climatic conditions correspond to the rainfall. Periods of low rainfall during the growing season are generally associated with high temperatures and hot winds. Conversely an abundance of moisture usually means moderate temperatures and absence of hot winds.

TABLE I—SUMMARY OF THE RAINFALL (IN INCHES) AT MANHATTAN, KANSAS, FOR THE GROWING MONTHS OF 1913 TO 1918 INCLUSIVE

Year	April	May	June	July	August	September	Total	Total for the three summer months.
1913	2.96	7.18	1.55	0.17	0.65	5.69	18.20	2.37
1914	1.19	2.33	4.58	2.40	3.56	5.76	19.82	10.54
1915	2.04	9.45	6.69	12.01	3.07	3.92	37.18	21.77
1916	2.17	6.40	7.43	1.92	0.76	8.12	26.80	10.11
1917	4.59	5.04	4.80	0.68	6.92	1.63	23.66	12.40
1918	3.74	4.89	1.33	2.26	3.71	2.31	18.24	7.30

The years 1913, 1916, and 1918, were exceptionally poor corn years, due to the extreme drouth of midsummer and the prevalence of hot winds. These conditions had a direct influence on the number of silks present on the plants and consequently on the location of the eggs. Conditions were somewhat better in 1914 and 1917 with the result that the growth and development of the plants was more nearly normal. The best year of the six that these investigations have been under way was 1915, when the midsummer rainfall was excessive and the temperature was moderate.

GENERAL OBSERVATION ON THE OVIPOSITION OF THE CORN EARWORM IN THE FIELD

Oviposition normally occurs at night, the adults being most active at this time. During the clear, hot days of midsummer, the moths usually begin flying and feeding about 5:30 p. m., and egg laying begins shortly after, continuing often until dawn. On cloudy days, or during the cool days of fall, oviposition may occur in the daytime. Until the corn crop is fully matured, eggs are rarely found on plants other

than corn, and a study of oviposition on corn is a study of the oviposition of the species.

A single female is capable of depositing from 500 to 2,000 eggs, and as high as 570 may be deposited in a single night. The eggs are laid singly, and generally only one or two on a plant. In ovipositing, the female lays from three to six eggs, then feeds for a short period before resuming oviposition, this process being repeated throughout the night.

Destruction of the Eggs by Natural Agencies

In the course of these studies, it was found that many natural agencies were responsible for the destruction of the eggs, or at least for their removal from the plant within a short time after deposition. The principal predaceous enemy of the egg was found to be the common flower-bug (*Triphleps insidiosus* Say) which often destroyed from 25 to 50 per cent within 24 hours after deposition. Other predaceous enemies were the larvæ and adults of the lady beetles *Hippodamia convergens* Guer., *H. 13-punctata* Linn., *H. parenthesis* Say, *H. glacilis* Fabr., *Adalia bipunctata* Linn., *Megilla fuscilabris* Muls., and *Cyclonida munda* Say. In addition, the larvæ of the lace wing (*Chrysopa* sp.) were often observed feeding on the eggs. A number of insects in feeding cut off many corn silks which bear eggs and these fall to the ground. Many eggs are also removed from the plants by winds and beating rains. Two parasites, *Trichogramma pretiosa* Riley and *Telenomus heliothidis* Ash., attack the eggs, but their presence had no influence on the egg count.

Presentation of Experimental Data

This study of oviposition and silking has been in progress for a period of six years, and during that time 128 plants representing four varieties of corn have been examined regularly for eggs of the corn earworm, and the same number of rows followed with regard to silking. The period represents one exceptionally bad earworm year (1914), two years of about normal conditions (1913 and 1918), and three years of light corn earworm injury (1915, 1916, and 1917). This period is also one presenting extremes of climatic conditions from excessive drouth and hot winds to high rainfall and moderate temperatures. The detail data obtained in these studies are summarized in Table II to show the total number of eggs found on each variety of each date of planting and in Table III is shown the location of the eggs with relation to the date of planting. The data secured from the plantings of July 1 in 1914 and 1915 are included in the discussion which follows wherever they are applicable. There are a number of instances, however, where these data are omitted, since they do not represent average conditions.

TABLE II—SUMMARY OF THE TOTAL NUMBER OF EGGS DEPOSITED ON EACH VARIETY OF EACH DATE OF PLANTING PLOT, MANHATTAN, KANS., 1913–1918

Variety	Planted		1913	1914	1915	1916	1917	1918	Total
Boone	April	15	6	2	2	1	1	17	29
County	May	1	4	6	4	0	2	10	26
White	May	15	21	10	4	7	3	3	48
	June	1	54	22	4	10	1	3	94
	June	15	97	206	3	11	9	178	504
	July	1		341	47				
Commer-	April	15	19	34	6	2	1	33	95
cial	May	1	18	19	0	1	2	3	43
White	May	15	21	34	2	9	7	4	77
	June	1	92	71	3	8	4	11	189
	June	15	181	391	6	13	6	90	687
	July	1		349	67				
Kansas	April	15	13	35	4	5	6	14	77
Sunflower	May	1	1	8	3	0	15	5	32
	May	15	6	13	1	3	2	4	29
	June	1	29	545	1	10	0	22	607
	June	15	9	258	10	16	8	209	510
	July	1		618	44				
Hildreth	April	15	11	7	3	0	4	23	48
	May	1	22	4	2	4	2	8	42
	May	15	9	13	5	1	0	3	31
	June	1	109	257	3	11	5	33	418
	June	15	63	928	8	17	14	212	1242
	July	1		475	98				

TABLE III—SUMMARY OF THE LOCATION OF THE EGGS ON THE DIFFERENT VARIETIES WITH RELATION TO THE DATE OF PLANTING, MANHATTAN, KANS., 1913–1918

Variety	Planted		Leaf surface		Silk	Husk	Tassel	Stalk	Total
			Upper	Lower					
Boone	April	15	18	0	2	2	1	6	29
County	May	1	8	2	10	2	2	2	26
White	May	15	15	2	12	3	0	16	48
	June	1	23	4	25	10	5	27	94
	June	15	234	41	91	25	40	73	504
Commer-	April	15	21	4	53	0	5	12	95
cial	May	1	6	6	15	1	0	15	43
White	May	15	28	5	27	0	0	17	77
	June	1	62	19	2	3	2	101	189
	June	15	299	66	196	6	36	84	687
Kansas	April	15	12	4	47	2	5	7	77
Sun-	May	1	7	1	21	0	1	2	32
flower	May	15	9	7	7	0	0	6	29
	June	1	77	32	390	43	6	59	607
	June	15	137	54	142	24	42	111	510
Hildreth	April	15	8	2	13	6	6	13	48
	May	1	17	5	3	0	2	15	42
	May	15	13	6	4	0	1	7	31
	June	1	152	28	123	19	10	86	418
	June	15	349	92	562	9	83	147	1242

DISCUSSION OF EXPERIMENTAL DATA

Number of Broods

The number of generations of the earworm present annually in a locality is of special importance in a consideration of many control measures. From the literature quoted by Quaintance and Brues,[1] the number of generations varies from one or two in Ontario to six or seven in southern Texas. Headlee[2] determined the actual number of broods in Kansas to be three, his conclusions being based on frequent egg counts made in the field during 1908 and 1909. The results

[1] Quaintance, A. L., and Brues, C. T. The Cotton Boll-worm, U. S. Dept. Agric., Bur. Ent., Bul. 50, 155 p., 27 figs., 25 pl. 1905.

[2] Headlee, T. J., *op. cit.*

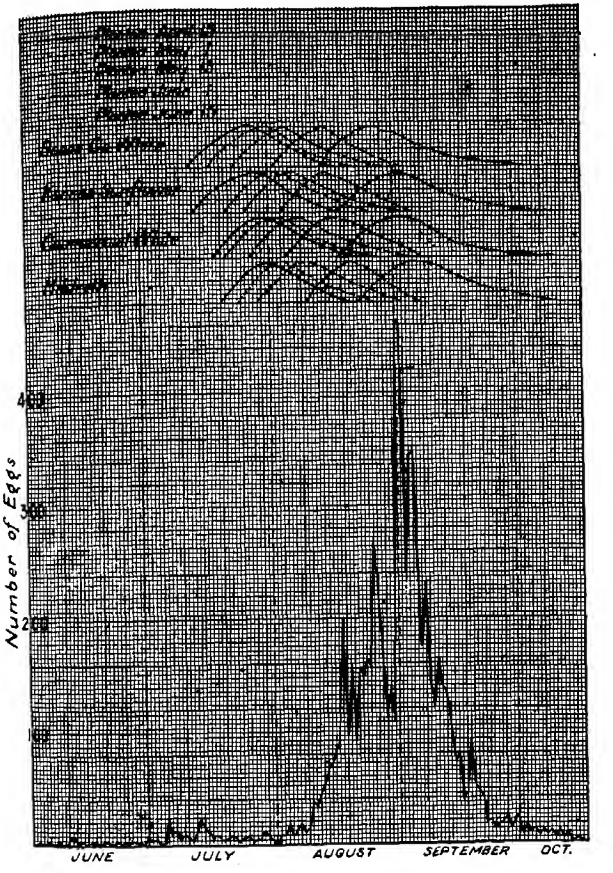


Fig. 7. Graph showing the total number of eggs found daily for the years 1913 to 1918, and the average date of first, maximum and last silking for each variety of corn with relation to the date of planting.

of the present work confirm the findings of Headlee since during the six years that these investigations have been in progress three distinct broods have been in evidence each season. Life history studies conducted under practically natural conditions have shown that a small partial fourth brood may emerge late in the fall. The results of the present study, however, indicate that this brood is of little importance, especially with regard to corn.

Figure 7, which shows the total number of eggs found for each day during the six years, indicates the number of broods and the approximate period that each brood was present. Similar curves drawn for each of the years resemble very closely the curve for the six years, except that there is some variation in the appearance of the broods with the different years due to environmental factors. There is a distinct overlapping of the broods and the point of maximum emergence is not greatly emphasized for the first two broods. The first brood usually begins to emerge during the first week in June, and reaches its maximum about June 15. The second brood appears about July 4, and is at its maximum July 13. The third brood begins emerging about August 10, and the maximum is reached during the last days of the month, and the first days of September. As indicated by the chart, the first two broods are of relatively little importance as compared with the third brood, and in developing a system for the reduction of earworm injury to corn the problem becomes one of protecting it from this last brood.

Silking

The studies at this station in 1908 and 1909 emphasized the fact that the moths exhibited a decided preference for the silks for oviposition, and that a corn plant was in its most attractive stage during the period of silking. Other investigations also showed that a large per cent of the larvæ entering the ear originated from eggs deposited on the silks. With these points in mind it became evident that in the development of many of the control measures it would be necessary to study the silking of the corn plants with especial reference to oviposition, and the data presented emphasizes the importance of this point. The average period of silking for each variety with regard to date of planting is shown in Table IV, and this data is also graphically presented in Figure 1 with relation to the oviposition in the field.

An examination of the table indicates that the date of silking is dependent on the variety rather than on the date of planting. Boone County White was the first variety to begin silking and to reach maximum silking. Kansas Sunflower and Commercial White were a few days later, while Hildreth was the last variety to silk. There was relatively little difference in the period of silking of Boone County White, Kansas Sunflower, and Commercial White, while in the case of Hildreth the period was much shorter. Likewise the period between first silking and maximum silking is shorter in Hildreth than in the other varieties.

It is also of interest to note that while the plantings were made at intervals of two weeks, the dates of silking show a difference of less

TABLE IV—AVERAGE PERIOD OF SILKING FOR EACH VARIETY IN EACH DATE OF PLANTING PLOT, MANHATTAN, KANS., 1913-1918

Variety	Dates of silking: Planted		Began	Maximum	End	Period of silking, days	Period between first and maximum silking, days
Boone County White	April	15	7-12	7-26	8-18	37	14
	May	1	7-17	7-31	8-24	38	14
	May	15	7-23	8-4	8-31	39	12
	June	1	8- 2	8-14	9- 3	32	12
	June	15	8-14	8-27	10- 3	50	13
Commercial White	April	15	7-18	7-30	8-24	37	12
	May	1	7-21	8- 2	8-28	38	12
	May	15	7-27	8- 8	9- 5	40	12
	June	1	8- 2	8-17	9- 8	34	12
	June	15	8-18	9- 3	10-10	53	16
Kansas Sunflower	April	15	7-13	7-28	8-19	37	15
	May	1	7-21	8- 1	8-26	36	11
	May	15	7-26	8- 6	9- 3	39	11
	June	1	8- 4	8-15	9-19	33	11
	June	15	8-18	9- 2	10-10	53	15
Hildreth	April	15	7-20	7-31	8-22	33	11
	May	1	7-24	8- 3	8-27	34	10
	May	15	7-29	8-10	9- 3	38	12
	June	1	8-10	8-21	9- 8	29	11
	June	15	8-22	9- 5	10-11	50	14

than a week between the plantings of April 15 and May 1, and May 1 and May 15. In the later plantings, however, the interval between silking approximates the difference between dates of planting. It is also worthy of notice that the period of silking for all varieties is much longer in the planting of June 15, and that the shortest period occurs in the planting of June 1. In the first three plots there seems to be a tendency for the period of silking to be prolonged with the delay in planting.

The present studies indicate that silking is influenced by a number of factors such as climatic conditions and pollination. Under favorable conditions a plant usually remains in silk from four to eight days. During years of low rainfall and hot winds, fewer silks are produced and many of the silks that do appear are destroyed within one or two days by the hot winds. Pollination is often prevented, delayed or incompleted and the silk may continue to grow to an unusual length and remain green for a much longer time. An examination of the daily records shows that during the period the plants under observation were silking, the majority of the eggs were found on the silks, and any factor that influenced silking had its influence on the number and location of the eggs.

Location of Eggs

A knowledge of the parts of the plant selected by the moths for oviposition is important in developing certain measures of control. This is especially true in working out a spraying program, a time of planting experiment, or in a study of varieties of corn with relation to their resistance to corn earworm injury.

During the six years that these investigations have been in progress, 6,867 eggs (Table V) have been found on the plants under observation. Of these, 2,247 or 32.7 per cent were on the upper surface of the leaves, and 2,100 or 30.6 per cent on the silks.

TABLE V—SUMMARY SHOWING THE LOCATION OF THE EGGS ON 128 CORN PLANTS UNDER OBSERVATION AT MANHATTAN, KANS., 1913–1918

Year	Leaf surface		Silk	Husk	Tassel	Stalk	Total
	Upper	Lower					
1913	358	57	117	30	4	219	785
1914	1,413	499	1,556	100	449	629	4,646
1915	70	7	177	11	11	54	330
1916	48	12	12	1	22	34	129
1917	19	4	59	6	0	4	92
1918	339	66	179	34	124	143	885
Total	2,247	645	2,100	182	610	1,083	6,867
Per cent of total	32.7	9.4	30.6	2.6	8.9	15.8	100.0

As indicated by the table, there is a marked variation in the number and location of the eggs in the different years, a condition influenced largely by the character of the year. An analysis of the data shows that the moths chose the silks, the upper surface of the leaves and the stalks for oviposition. Of these the silks were preferred, and during those years when the plants silked normally, the larger number of eggs were found on the silks. When silking was delayed or prevented, as in 1913, 1916, and 1918, by drouth and hot winds, the upper surface of the leaves and the stalks were selected in preference to the other parts. In considering the places selected for oviposition, it must be remembered that the plant under favorable conditions is in silk from four to eight days, while the other parts of the plant, especially the leaves and stalk, are available during the entire life of the plant. It is also of interest to note that a full grown plant has about twenty square feet of upper and lower leaf surface, and that eggs may be deposited on any part of the leaf.

Relation of Oviposition to Date of Planting

Since the amount of injury is obviously influenced by the number of eggs deposited on the plant, and especially on the ear and silks, a study of oviposition is necessary for the interpretation of the data secured in "a time of planting experiment." The date of planting experiment at this station has been conducted primarily to determine the optimum time to plant corn to obtain the maximum yield and the minimum amount of corn earworm injury. In the present discussion, the relation existing between date of planting and oviposition is considered, the relation between yield and injury being reserved for a future paper.

As was shown in Tables II and III, there is a variation in the number and location of the eggs with regard to the different varieties planted at the same time, and this condition is true with relation to the varieties planted at different dates. A summary of the total number of eggs found on each variety for each date of planting is presented in Table

VI, and in Table VII these data are summarized to show the number and location of the eggs with relation to the date of planting for the six years.

TABLE VI—SUMMARY OF THE TOTAL NUMBER OF EGGS ON EACH VARIETY OF EACH DATE OF PLANTING AT MANHATTAN, KANS., 1913–1918

Variety	Date of Planting					
	April 15	May 1	May 15	June 1	June 15	Total
Boone County White	29	26	48	94	504	701
Commercial White	95	43	77	189	687	1,091
Kansas Sunflower	77	32	29	607	510	1,255
Hildreth	48	42	31	418	1,242	1,781
Total	249	143	185	1,308	2,943	4,828

TABLE VII—SUMMARY OF THE NUMBER AND LOCATION OF THE EGGS WITH RELATION TO THE DATE OF PLANTING, MANHATTAN, KANS., 1913–1918

Date of Planting	Leaf surface		Silk	Husk	Tassel	Stalk	Total
	Upper	Lower					
April 15	59	10	115	10	17	38	249
May 1	38	14	49	3	5	34	143
May 15	65	20	50	3	1	46	185
June 1	314	83	540	75	23	273	1,308
June 15	1,019	253	991	64	201	415	2,943

It is obvious from the results thus presented that April 15 is too early from the standpoint of oviposition for all varieties, with the possible exception of Boone County White, and June 1 is too late. More eggs were laid on the plants planted April 15 than on those planted May 1, and in the case of Commercial White, Kansas Sunflower and Hildreth than on those planted May 15. A decided rise in the number of eggs on all varieties is seen in the plots of June 1 and June 15, and similar results are noted for the important parts of the plant selected for oviposition, although they are not so pronounced. The relationship between the date of planting and oviposition is more clearly brought out in Table VIII which shows the frequency with which the lowest number of eggs were found for each variety with regard to time of planting. In the case of Boone County White, the fewest eggs were found on April 15 planting in three years of the six. In five years the lowest number of eggs on Commercial White were on the May 1 planting, and in three years the same was true for Kansas Sunflower. On the other hand, the fewest eggs on Hildreth were on the planting of May 15 in three years of the six. Summarizing the data for the four varieties during the six years, it is noted that in 12 instances out of a possible 24, the fewest eggs have been found on the May 1 planting. May 15 is second with six instances, April 15 is third, and in one case the lowest number was found on the June 1 plot.

TABLE VIII—FREQUENCY WITH WHICH THE LOWEST NUMBER OF EGGS WERE FOUND ON EACH VARIETY WITH REGARD TO DATE OF PLANTING, MANHATTAN, KANS., 1913–1918

Variety	April 15	May 1	May 15	June 1
Boone County White	3	2	1	
Commercial White	1	5		
Kansas Sunflower		3	2	1
Hildreth	1	2	3	
Total	5	12	6	1

The results of six years' investigation show that there is a direct relation between the number of eggs deposited on a variety and the date of planting, and that there are several factors to be considered in developing an optimum time to plant corn. Headlee[1] pointed out that corn planted about May 1 was less injured by the corn earworm than corn planted April 15 or May 15 and later. He attributed this to the fact that early planted corn passes through its most attractive stage—silking—before the third brood of moths appear, and also that corn planted too early suffers a setback from climatic conditions. The results of the present studies in general confirm the findings of Headlee, and the data on oviposition offer an explanation for this condition. In the light of the present investigations, however, the variety of corn must be considered with relation to the date of planting, since each variety exhibits certain variations with regard to growth, time of silking, period of silking, and maturing. In addition, there are certain morphological characters that may have an influence. As has been pointed out, the number of eggs increases with the delaying in silking and maturing of the varieties, and the early silking and maturing varieties have had the fewest eggs.

The relation between the total number of eggs found daily during the six years, and the average period of silking is shown graphically in Figure 7. As seen by this figure, the maximum emergence of the second brood of moths is about July 10, and the third brood begins to emerge about August 8. Obviously the optimum date to plant corn with regard to the earworm would be at such a time as to bring it into silk between these two broods. A study of the figure shows that corn planted from April 15 to May 15 silks at approximately the same time, being but a few days later for each delay of two weeks in sowing. In the case of the first two dates of planting, the maximum silking period is passed before the emergence of the third brood. The May 15 plot is just reaching its maximum period of silking when the third brood begins to emerge, while the last two plots are in full silk at the time this brood is abroad. The variation in the number of eggs on the varieties in the earlier plots is due largely to the time of silking with relation to the second brood of moths.

From the data shown in Table VIII, it is seen that in the greatest number of instances the lowest number of eggs were found on the May 1 plot, with the May 15 plot second, and the April 15 plot third. In other words, the corn planted April 15 was in silk during the latter part of the period that the second brood of moths were ovipositing. The May 1 plot was in maximum silk about August 1, or at a time when the second brood had practically disappeared, and the third brood had not

[1] Headlee, T. J., *op. cit.*

emerged. An analysis of the data indicates that from the standpoint of the number of eggs deposited, Boone County White can be planted from April 15 to May 1, Commercial White about May 1, and Kansas Sunflower and Hildreth from May 1 to May 15. Summarizing the results for the four varieties, May 1, under favorable conditions, is apparently the optimum time to plant corn to escape injury from the corn earworm.

Relation of Oviposition to Different Varieties of Corn

The number and location of the eggs is worthy of consideration in a study of the resistance of different varieties of corn to earworm injury. Thus far little work has been done along the line of immunity, and in the investigations that have been conducted emphasis has been placed on the presence or absence of larval injury with relation to the morphological characters of the plant. Collins and Kempton,[1] in breeding sweet corn resistant to the corn earworm, considered four protective characters, namely: the distance the husk extends beyond the ear; the thickness of the husk covering; the texture of the husk, and the presence or absence of husk leaves. While a study of the plant characteristics is of great importance in such an investigation it would seem that a study of the oviposition would be important in correlating and interpreting the results. As has been pointed out, the moths show a preference for the silks, and, as will be shown, there is a direct relation between silking and the number of eggs deposited. The present studies also show that fewer eggs are deposited on the husks than on any other part of the plant. In the investigations under discussion, there has been considerable variation in the number of eggs deposited on the four varieties grown in the plots, a condition that has prevailed practically every year. A study of the data presented in Table II shows that in 43.7 per cent of the 32 plots grown in the six years, Boone County White has had the lowest number of eggs, Kansas Sunflower has had the fewest eggs in 28.3 per cent of the plots, Commercial White in 15.6 per cent, and Hildreth in 12.5 per cent.

A comparison of the data summarized in Table III indicates that there is also a similar variation in the location of the eggs on the different varieties, although this difference is not so pronounced. During the time these investigations have been in progress, fewer eggs have been found on all parts of Boone County White, except the husk (Table IX), than on each of the other varieties. Likewise,

[1] Collins, G. H., and Kempton, J. H., Breeding Sweet Corn Resistant to the Corn Earworm. In Jour. Agric. Research, Vol. XI, No. 11, p. 549–572. 1917.

the number of eggs on Hildreth has exceeded those on the other varieties.

TABLE IX—SUMMARY OF THE LOCATION OF THE EGGS FOUND ON THE DIFFERENT VARIETIES, MANHATTAN, KANS., 1913-1918[1]

Variety	Leaf surface		Silk	Husk	Tassel	Stalk	Total
	Upper	Lower					
Boone County White	444	74	277	48	88	158	1,089
Commercial White	575	146	371	23	91	301	1,507
Kansas Sunflower	486	210	699	75	146	301	1,917
Hildreth	742	215	753	36	285	323	2,354

[1] Includes plots of July 1.

There are many factors to be considered with relation to the oviposition on the different varieties of corn which offer an extensive field for further investigation. In connection with the data just presented, it is of interest to note that there is an evident relation between the time of silking and maturing, and the number of eggs. Boone County White, which had the lowest number of eggs, is the earliest variety in point of silking and maturing. Kansas Sunflower is second in this respect, Commercial White third, and Hildreth last. Kansas Sunflower, however, ranks third in the total number of eggs found on a variety in the six years, due to the fact that the plant in the plot of June 1, 1914, produced three ears at intervals of several days, with the result that the plant was in silk for an exceptionally long time, and a large number of eggs were deposited on these later silks. In the work under discussion, several instances were noted where plants having rather smooth leaves had fewer eggs deposited on them than on plants having the leaves rough and hairy. Similar observations have been noted in the case of the stalk. The number of leaves borne by a plant and the leaf area are to be considered, since the number present may vary from 8 to 18, and there is a corresponding variation in the leaf area. The number of ears produced by a plant is also important, since a plant may have from one to four ears, each one silking at a little different time and consequently the plant is attractive to the moths for a longer period. Many other factors might be mentioned in connection with the location of the eggs on the different varieties, but since, in the present work, the morphology of the plants has not been followed closely, it does not seem advisable to discuss them further. At the present time an investigation is being conducted along the lines suggested with a large number of varieties, and more extended information is being obtained from this work.

SUMMARY

A study of the oviposition of the corn earworm on different varieties of corn plants with relation to the date of planting and period of silking has been made during the past six years. This work represents

the daily number of eggs deposited on 128 individual plants and the silking period of 128 rows of corn.

Three distinct broods of the corn earworm occur each year, the first brood of moths emerging early in June, the second brood about July 10, and the third brood about August 10. The maximum emergence occurs about two weeks after the first emergence. The first two broods are of little importance in comparison with the third brood.

The date of silking is dependent on the variety rather than on the date of planting. While the plantings were made at intervals of two weeks, the dates of silking show a difference of less than a week for corn planted April 15, May 1, and May 15.

The moths show a decided preference for the silks for oviposition. When these are not available, the upper surface of the leaves and the stalks are selected. Relatively few eggs are deposited on the lower surface of the leaves, the husk, or the tassel.

There is a distinct relation between the date of planting and the number and location of the eggs. From the data presented, April 15 is too early to plant corn from the standpoint of oviposition, and June 1 is too late. The variety of corn, however, is to be considered in developing the optimum date to plant corn, since each variety exhibits certain variations which will have an influence on the number of eggs deposited on it. An analysis of the data indicates that from the standpoint of the number of eggs deposited, Boone County White can be planted from April 15 to May 1; Commercial White about May 1; and Kansas Sunflower and Hildreth from May 1 to May 15. Considering the results for the four varieties, May 1, under favorable conditions, is the optimum time to plant corn to escape the corn earworm.

Considerable variation has been noted in the number of eggs deposited on the four varieties of corn. In 43.7 per cent of the plots grown in the six years, Boone County White has had the lowest number of eggs. Kansas Sunflower has had the fewest eggs in 28.3 per cent of the plots, Commercial White in 15.6 per cent, and Hildreth in 12.5 per cent. A similar variation was noted in the location of the eggs on the different varieties. There are a number of factors to be considered with relation to oviposition on varieties of corn, the principal ones being the time and period of silking, the time of maturing, and certain morphological characters of the plant.

PRESIDENT W. C. O'KANE: The next paper is by R. W. Leiby.

THE CORN-STALK BORER, DIATRAEA ZEACOLELLA DYAR

By R. W. LEIBY, *Raleigh, N. C.*

(Withdrawn for publication elsewhere)

MR. W. J. SCHOENE: Evidently the cornstalk borer is not quite so injurious in Virginia as in North Carolina. We have made a few observations and in coöperation with Mr. W. J. Phillips, of the Bureau of Entomology, plowing-out experiments have been in progress during the past two years. The past autumn an attempt was made to check up the injury by the first and second broods of larvæ. This was done by examining each stalk and weighing separately the product of the stalks injured by the various broods. It appears from the several fields examined that the injury by the second brood, that is the injury of the larvæ that attacks the corn when it is nearly mature, is of very little importance. The main injury is caused by the first brood of larvæ.

Adjournment.

Meeting of the Cotton States Entomologists

There was held a meeting of the Cotton States Entomologists at Vicksburg, Miss., and Tallulah, La., on March 1, 2 and 3, to consider several of the most important entomological problems of the cotton belt. The meeting was opened on the evening of March 1, at which time representatives reported on entomological activities in their respective states including teaching, research, quarantine and extension. This was followed by a discussion on the "Pink Bollworm Problem," by Dr. W. D. Hunter. The entire meeting reassembled at Tallulah on March 2, for an examination of the cotton dusting machinery, and then adjourned to the Opera House where Mr. B. R. Coad took charge of the meeting and explained the investigations conducted at the United States Delta Laboratory at Tallulah, La., and the present status of boll weevil poisoning.

Dr. Van Dine made a very interesting address on "Mosquito Control." The remainder of the session was continued at Vicksburg and included a paper on "The Sweet Potato Weevil Fight," by Mr. J. A. Graf, followed by discussions. The European corn borer problem was discussed at some length.

Mr. J. A. Montgomery of the Florida State Plant Board presented a most interesting paper on the "Standardization of Inspection Laws." Following a discussion on this paper a committee was appointed to submit at as early a date as possible a draft for consideration and subsequent adoption by the various cotton states. The meeting ended by a discussion on citrus canker, port inspections, and bee disease inspection, including the enforcement of foul brood laws.

The Association of Southern States Entomologists has no by-laws. Its existence is mutual on the part of entomologists both federal and

state. Any worker in the Southern States is a member of the Association.

It has no schedules for meetings, but the meetings are called whenever any grave matter confronting the entomologists requires serious and immediate attention. All the meetings so far have been for specific purposes, they have been well attended and at every meeting definite policies have been formed for the guidance of the various workers in their respective states in order to achieve uniform and concerted action. At this meeting over fifty representatives, including nearly all the Southern States, were present.

A. F. CONRADI,
Secretary.

RESOLUTIONS ADOPTED BY THE COTTON STATES ENTOMOLOGISTS AT VICKSBURG, MISS., MARCH 1, 2 AND 3, 1920

BE IT RESOLVED, That the thanks of this Association be extended to the Association of Southern Agricultural Workers for its invitation to affiliate with that Association, that such invitation be hereby accepted, and that the President of our Association be delegated and authorized to arrange for such affiliation.

BE IT RESOLVED, That it is the conviction of the members of this Association that the European corn borer, Japanese beetle, Oriental peach moth and gipsy moth, foreign pests established in the northeastern United States, constitute a potential menace to the agricultural prosperity of the Southern States, and we urge upon the National Government such steps and appropriations as are necessary to prevent the further spread of these destructive pests in the United States, that earnest efforts should be made to eradicate them.

BE IT RESOLVED, That the experience of Texas and Louisiana with the pink bollworm emphasizes the importance of each state doing systematic scouting work for such dangerous insect pests as the pink bollworm, European corn borer, Oriental peach moth, sweet potato weevil, etc.

BE IT RESOLVED, That it is apparent that there is need for crop pest control laws, with the necessary funds to enforce them, in every state to enable responsible authorities to deal promptly and effectively with dangerous pests wherever they may become established.

BE IT RESOLVED, That while, in our opinion, a wide diversity in climatic conditions, horticultural products and insect fauna makes impractical the application of uniform nursery inspection laws and regulations in all the states of the United States, it is, nevertheless, desirable, in the interests of increased horticultural development and the economical administration of inspection measures, that such laws and regulations be standardized in the Southern States, and uniformity therein secured as far as may be possible, and that to this end it is recommended that nursery inspection laws, or rules and regulations placed in effect in the Southern States include the following essentials:

1. Nursery inspection certificates should remain continuously in force (instead of expiring at a certain date each year) as long as the nursery continues to pass frequent and thorough inspections.

2. Nursery inspection fees and license fees should be abolished.

3. Each state should require a valid and unaltered certificate of inspection of uniform size and appearance attached to each container of nursery stock. For this

purpose is suggested a No. 8 raw hide tag with brass eyelet, with certificate of inspection at top, address space in center, and address of nurseryman at the bottom, and that writing of consignee's address on the tag shall constitute cancellation of that certificate tag for further use.

4. Quarantines should be made as nearly as possible to conform to quarantine rules of the Federal Horticultural Board.

5. Inspection certificate tags should be issued only by the state inspector and printing of copies of these certificates by others should be prohibited as constituting a counterfeiting of the certificate.

6. All certificate tags should be serially numbered and the use of each tag accounted for by the nurserymen sending to the inspector a complete record of the stock sold or shipped under such certificate tag. This in order that the state inspector may promptly inspect past shipments from the nursery where any dangerous pest or disease appears therein.

Your committee is of the opinion that a committee of three members should be appointed by the President of this Association to recommend standard practices in handling the following phases of nursery inspection work:

A. Standardization of fumigation requirements, especially as to dosage and time of exposure.

B. Use of fumigation certificates.

C. Listing the plants which should be dipped in insecticides, the strength of such dips and manner of dipping.

D. State requirements applying to interstate shipments.

E. Use of certificate tags and permit tags of the same color in all Southern States during each shipping season.

BE IT RESOLVED, That this Association extend its thanks, and same are hereby extended to Dr. W. D. Hunter, and Mr. B. R. Coad, of the Bureau of Entomology, and their associates for the demonstrations and explanations of boll weevil poisoning methods afforded us at the Tallulah Laboratory, to Mr. B. R. Coad in assisting in compiling the proceedings of this meeting, to the management of the National Park Hotel for providing this Association conveniences for holding its session, and to representatives of the Vicksburg Press and such business interests of Vicksburg as have contributed in various ways to the success of our meetings and the comfort and convenience of our members.

RESOLUTION CONCERNING THE PINK BOLLWORM SITUATION, ADOPTED BY THE ASSOCIATION OF COTTON STATES ENTOMOLOGISTS AT VICKSBURG, MISS., MARCH 3, 1920

WHEREAS, The recurrence of the pink bollworm of cotton in the previously infested area in southeastern Texas, the discovery of the insect at points outside the previously known infested area and the discovery of serious infestations in southwestern Louisiana, from which latter area large shipments of cotton seed have been made to other portions of the state of Louisiana, create a critical situation menacing the future of the whole cotton industry of the United States and

WHEREAS, The situation so created is one of emergency calling not only for the continuation of the present eradication work but also for prompt and drastic measures to prevent the further dissemination of the pest, now therefore

BE IT RESOLVED, By the various entomologists, quarantine officials and other agricultural agents assembled at this meeting of the Association of Cotton States Entomologists at Vicksburg, Miss., this 3rd day of March, 1920, that in order to prevent the further spread of the pink bollworm the Federal Horticultural Board should impose a quarantine against the movement from the states of Texas and

Louisiana into other states of all materials and things which are, or would be likely, to carry and distribute infestation, and this Association respectfully, but nevertheless earnestly and forcefully, urges the Federal Horticultural Board to take such action without unnecessary delay and

BE IT FURTHER RESOLVED, That those in attendance at this meeting as individuals and officials pledge to the Federal Horticultural Board and the state authorities our whole-hearted and unstinted support in the efforts now being made to eradicate the pink bollworm and

BE IT FURTHER RESOLVED, That it is the unanimous opinion of those assembled that the authorities of the several states in the cotton belt should immediately and forthwith impose quarantines, effective at once, against the movement into these states from the states of Texas and Louisiana of all things and materials which are likely to introduce the pink bollworm.

Scientific Notes

Butterfly Migrations. Many instances have been recorded of migrations of large numbers of butterflies, and the following quotations, taken from the writer's diary, may prove interesting additions to the records:

"Brownsville, Texas, June 28, 1912. There was a migration of butterflies, *Libithya bachmanni*, over Brownsville yesterday—flying north close to the ground, almost against a northeast wind, in spite of———'s theory that insects can migrate only with the wind."

"July 16. Another migration of butterflies (Libithya) flew over the post today, flying almost due east by the thousands. Most of them fly within six feet of the ground, the majority closer. They fly at a rate of eight to twelve miles per hour."

"July 17. The migration of butterflies continued all day, thousands of them flying through the streets of Brownsville."

"July 19. Those Libithya butterflies are flying over town thicker than ever today. There must be millions of them. I judge from their abundance the larvæ must live on mesquite or Texas ebony."

Unfortunately, definite records of wind direction and rainfall were not kept in the diary, as these might have an important bearing upon the time and direction of the migrations. But temperature and humidity were recorded, taken from readings of thermograph and hygrograph maintained in an insectary. These are briefly shown in the following table:

	Max. Tem.	*Min. Tem.*	*Max. Hum.*	*Min. Hum.*
June 28	88	67	96%	45%
July 16	90	73	94%	42%
17	90	73	93%	52%
18	90	75	94%	53%
19	91	76	94%	43%
Average for June	88	74	92%	62%
July	89	75	93%	53%

As seen by the table, there is not enough departure from normal temperature and humidity during the days of flight to in any way account for the migrations.

Another butterfly migration, noted by the writer, took place near La Romana, Santo Domingo, on a large sugar estate at the eastern end of the island. As the writer left Higueral the morning of March 6, it is not known whether the migration lasted longer than the two days.

"Higueral, R. D., March 4, 1914. Observed today, from window of my laboratory, a very considerable migration of large sulphur butterflies, *Catopsilia* (*Callidryas*) *eubule*, flying about northwest at an average height of ten to fifteen feet—some higher, but none close to ground. They linger at no flower or bush, and the flight is very rapid."

"March 5. The migration of sulphur butterflies continued throughout the day, they flying in the same direction as yesterday. As the larvæ of this genus breed on the species of Cassia and Pithecolobium, so large a number of adults must have matured in the scrub growth of Pithecolobium along the seacoast near Romana. It is evident that the large yellow Spilochalcis, that infests the pupæ and keeps this species in check in Porto Rico, does not occur in any abundance on this island."

E. GRAYWOOD SMYTH.

Roach Control. For several years the buildings of the Michigan Agricultural College have been the home of a flourishing colony of the large American roach, *Periplaneta americana*. The tunnels through which heat, water and electric power are distributed over the campus afford the best of facilities for the roaches to take advantage of changes in food supply and various comforts appreciated by roaches. During all this time the pests have been baited with everything which we supposed might be tempting to a rather well-fed roach, but with indifferent success, the roaches seeming to pay no particular attention to any of our offerings. Even Fluorid of soda, both as a dry powder, and mixed in flour, failed to do more than dispose of a few of them, and all this apparently because we had failed to provide an attractive bait in which to place poison. Finally it was noticed that the roaches love to collect on barrels of fermenting honey and water used in making honey vinegar, apparently attracted by the fermenting liquid which seeps through. Accordingly, a thin gruel of cotton-seed meal sweetened with a little molasses was cooked in a steam cooker and to this, when cool, was added a cake of yeast, and fermentation was allowed to start, after which a small quantity of dry, powdered arsenate of lead was stirred in and the offering placed in plates accessible to the roaches. The outcome was really gratifying. The first attempt resulted in the death of several hundred roaches. It is necessary to moisten the bait about once a day since the bait becomes ineffective as soon as it dries out.

R. H. PETTIT.

Historic Credits. Sanderson, in his Insect Pests of Farm, Garden and Orchard, figure 80, page 109, credits the illustration, following Riley, to Price, only to receive recently a letter from that gentleman, kindly placed at our disposal, to the effect that while he made the drawing of the "hopperdozer" it was by no means his invention, a credit that he never claimed. The figure was drawn by Mr. Price more than forty years ago when he was a youth and only recently had his association therewith come to his attention, hence the belated note. The inventor of the useful "hopperdozer" has been forgotten, apparently.

E. P. F.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

APRIL, 1920

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photoengravings may be obtained by authors at cost. The receipt of all papers will be acknowledged.—EDS.

Separates or reprints, if ordered when the manuscript is forwarded or the proof returned, will be supplied authors at the following rates:

Number of pages	4	8	12	16	24	32
Price per hundred, or less	$3.75	$8.00	$9.35	$10.30	$15.15	$20.00
Additional hundreds, or less	.55	1.15	1.75	1.75	2.75	3.75

Covers suitably printed on first page only, 100 copies, or less, $4.65; additional hundreds, or less, $1.40. Plates inserted, $1.25 per hundred, or less. Folio reprints, the uncut folded pages (50 only), sixteen page signature, or less, $1.85. Carriage charges extra in all cases. Shipment by parcel post, express or freight as directed.

The resolutions adopted by the cotton states entomologists and printed elsewhere in this issue give expression among other things to the prominent place recently introduced insects have taken among economic pests and voice once more the need of pushing control and exterminative measures. The situation is surely serious with the gipsy moth, the brown tail moth, the European corn borer in the northeastern section of the country, the Japanese beetle in New Jersey and the pink bollworm and the sweet potato weevil in the south, while the oriental peach moth appears fairly well established along portions of the Atlantic seaboard. Each of these insects presents a group of problems in relation to both control in the field and the restriction of spread, not to mention special cases in which extermination is being attempted or urged. This country has suffered enormous losses in the past due to introduced insects, some of which are now of only historic interest while others rank among the most destructive forms. It is possible and perhaps probable that our increasingly efficient quarantines will serve to at least check and may be indefinitely postpone the establishment of still other pests. The efficacy of such measures can be ascertained only by tests on a large scale because a rigid exclusion from one group of ports or one section of the country only makes the dissemination of a pest a little more difficult. Who can say that any but the most rigid quarantine will accomplish more? The probabilities favor a continuance of the conditions outlined above. The invader slowly or rapidly spreading, as the case may be, is normal wherever there is a chance of a species establishing itself in unoccupied territory. It may be possible to develop methods to such an extent

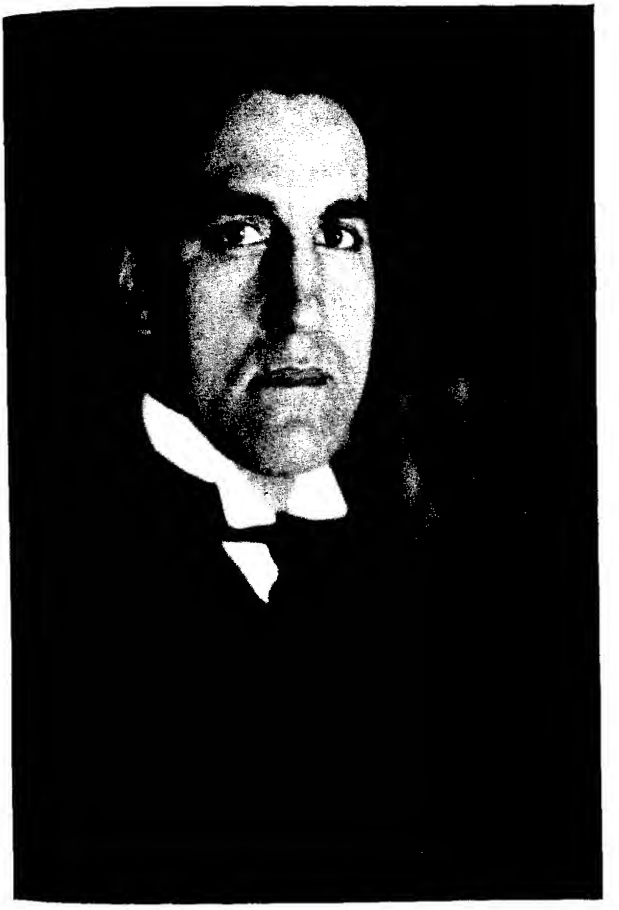
that the dangerous invader, if not absolutely excluded, will be detected so speedily that extermination, re-extermination when necessary, will occur repeatedly and when that time comes the possibilities and limitations of various methods will be better understood than now.

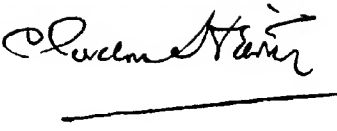
Obituary

CHARLES GORDON HEWITT

The science of entomology and its devotees have suffered an irreparable loss in the untimely death, on February 29, of Dr. Charles Gordon Hewitt, entomologist and consulting zoölogist of Canada. Dr. Hewitt had held these positions since September, 1909. He was the son of Mr. T. H. Hewitt and was born February 23, 1885, at Macclesfield, near Manchester, England. He attended the grammar school and later the University of Manchester, where he was a prize student and received the degree of Doctor of Science. In 1904 the latter institution appointed him lecturer and in 1907 demonstrator in zoölogy. Before leaving England to fill the position of Dominion entomologist he had been a member of several scientific societies. Besides studies on the larch saw-fly and other insects he had written an excellent monograph on the house-fly under the guidance of his teacher, Prof. Sydney J. Hickson. It was first published in three parts in the *Quarterly Journal of Microscopical Science* (1907–09) and in 1910 issued as a book by the University Press of Manchester. It remains one of the most valuable contributions to a subject of great economic importance. After taking up his position in Ottawa, Dr. Hewitt married Miss Elizabeth Borden, daughter of the former premier, Sir Frederick Borden.

The truly remarkable record of development and public service exhibited by Dr. Hewitt's department during the decade of his administration was clearly due to the unusual abilities of the man. Combining a thorough training in zoölogy with rare gifts as an investigator, executive talent of a high order and sympathetic insight into the achievements of other workers, not only in entomology but in biology generally, he could not fail to secure the affection as well as the confidence and admiration of all the men, and particularly the young men, whom he had chosen as aids in building up his department. His scientific interests, however, were not confined to his immediate, official environment. Realizing that very many of the native and introduced animals and the economic problems to which they give rise are identical in Canada and the northern United States, he took an actively constructive part in all deliberations, wherever men were





assembled in either of the sister commonwealths, to discuss practical matters relating to our insects, birds and mammals. At the same time he unceasingly encouraged amateurs, collectors and students to amass data and collections for the purpose of gaining a more satisfactory knowledge of the fauna of British America.

Those who were privileged to know Dr. Hewitt intimately, in the few leisure hours he could spare from his many strenuous and exacting duties, found in him an affectionate and considerate friend and, owing to his intense interest in good literature, music and painting, a very stimulating companion. There was another side of his nature that was not revealed to his friends in the United States as it related to his immediate home environment. This was his ardent interest in the education of boys. He was active in the Boy Scout movement and was president of the Ottawa Boys' Club, which made great progress while he was connected with it.

The great esteem in which Dr. Hewitt was held by his fellow scientists, both in the Dominion and in the United States, is shown by the fact that he was elected a Fellow of the Royal Society of Canada in 1913 and its honorary treasurer in 1914; that he was a member of the Canadian Wild Life Board, and had held presidential positions in three of the leading entomological societies: The Entomological Society of Ontario, the American Association of Economic Entomologists and the Entomological Society of America. He published a number of valuable entomological papers and addresses and had completed a book on the conservation of the wild life of Canada, a subject to which he had devoted much attention during the past few years. That he should have been stricken by pneumonia in the very beginning of what promised to be a long and brilliant career of service, both to his adopted country and to the United States, can only be attributed by his friends to overwork during and since the World War.

W. M. WHEELER.

Reviews

An Investigation of the Louse Problem, by WILLIAM MOORE and ARTHUR DOUGLASS HIRSCHFELDER. Research Publications, Vol. VIII, No. 4 (Studies in the Biological Sciences, No. 3). University of Minnesota, Minneapolis, Minn., July, 1919.

This pamphlet of 86 pages describes the methods of rearing lice, with notes on their biology, pathological effects of their bites, methods of control, the preparation of certain compounds used in the experiments, and bibliography. It is illustrated by six charts showing curves, and two figures. Valuable data are here recorded on the incubation period of eggs, length of instars, and the influence of temperature on egg production. A major portion of the paper deals with control methods, such as laundry processes, effect of hot water, dry heat, soap suds, fumigation, louse powders,

impregnation of underwear, etc. It was found that the lice and eggs are killed in the ordinary processes of laundering khaki and cotton garments at a temperature of about 115° F. for a period of 15 minutes. Woolen garments should be washed for fifteen minutes at a slightly higher temperature of about 120° F. Fumigation of clothing with chlorpicrin, 10 cc. to 2.5 cubic feet of space, for 30 minutes, heated with three one-liter flasks of water at 80° C., proved effective in killing the eggs, except in certain cases where rolled or folded tightly. Impregnation of the underwear was found to be a promising method of control between lousings. For this purpose the authors recommend active chemicals of low volatility like the halogenated phenols, such as dibrommetacresol, dichlormonobrommetacresol, and their sodium salts, dibromcarvacrol, and dibromxylenol. This publication will be especially useful to officers in charge of the sanitation of military camps.

W. E. Britton.

Destructive Insects Affecting Ohio Shade and Forest Trees, by J. S. Houser, Ohio Agr. Expt. Sta. Bul. 332, pages 159–487, plates I to LXX, 1918.

The author has given us in this volume a most excellent comprehensive account, based on practical experience, of some of the more important shade and forest tree insects of Ohio, rightfully stressing the conditions necessary for a satisfactory growth and development of trees as well as methods of controlling the insects which occasionally or frequently injure them. The author emphasizes, first, the selection of suitable species, their proper planting and protection from various mechanical injuries, electric currents and leaking gas. He holds that insect control, while possible under city conditions, is rarely so in the forest or farm lot. The establishment of a municipal tree-treating department is favored on economic grounds and for the guidance of communities the Cleveland ordinance relating to the management, protection and control of street trees is reproduced. There is a detailed and excellent discussion of spraying machinery and accessories, including spraying and banding materials.

The main portion of the work is devoted to brief summary accounts of some seventy-seven of the more important pests, grouped under leaf or foliage insects, scale and other sucking insects and boring insects. The work is illustrated by seventy plates, all of the figures being excellent and a considerable number original.

E. P. Felt.

Current Notes

Conducted by the Associate Editor

Dr. T. J. Headlee addressed the Connecticut Pomological Society at Hartford, Conn., February 12.

Mr. Arthur Gibson has been appointed acting Dominion entomologist *vice* Dr. C. Gordon Hewitt, deceased.

Mr. Kenyon F. Chamberlain, assistant entomologist, Connecticut Agricultural Experiment Station, resigned March 1.

Dr. C. L. Metcalf has recently been promoted from assistant professor to professor of entomology in Ohio State University.

Prof. George Macloskie, for thirty-one years professor of biology at Princeton University, and professor emeritus since 1906, died January 4, 1920. Between 1880

and 1891 Professor Macloskie published several papers, chiefly morphological and anatomical, dealing with insects.

Mr. Archibald H. Ritchie has resigned his official position in Jamaica to accept a position with sugar planters at Albion Estate, Yallahs P. O.

Mr. R. H. Hutchinson of the Bureau of Entomology resigned March 15, to accept a position with the H. K. Mulford Company, Philadelphia, Pa.

The American Honey Producers' League was organized at the meeting at Kansas City, Mo., January 6 and 7, called by the National Beekeepers' Association.

The thirty-first annual meeting of the California State Beekeepers' Association was held at the auditorium, Exposition Park, Los Angeles, on February 6 and 7.

The thirty-first annual meeting of the Pennsylvania Beekeepers' Association was held at Harrisburg on January 21, and was one of the most successful ever held in that state.

Mr. J. C. Crawford, for several years in charge of the Hymenoptera at the U. S. National Museum, and a specialist on the Chalcididæ, resigned his position in January, 1920.

Mr. M. J. Moloughney, entomological branch, Canadian Department of Agriculture, is in ill health, and a three months' additional sick leave was granted him from February 9, 1920.

Wisconsin has a new apiary inspection law now in force which prohibits shipping bees into the state except on permit of the state entomologist, unless accompanied by an official certificate of inspection.

The meeting of the National Beekeepers' Association was held at the Statler Hotel, Buffalo, N. Y., March 9–11, and the program included addresses by Dr. E. F. Phillips, Prof. F. B. Paddock and Prof. George H. Rea.

Mr. R. R. Reppert, assistant state entomologist of Virginia, has resigned to accept the position of extension entomologist in the state of Texas. Mr. Reppert expected to assume the duties of this position early in March.

The laboratory of the Bureau of Entomology at Grand Junction, Colo., where investigations of the codling moth have been carried out for the past few seasons in coöperation with the Colorado Agricultural College, has now been discontinued.

Mr. G. E. Sanders, Annapolis Royal Laboratory, and Mr. W. A. Ross, Vineland Laboratory, Entomological Branch, Canadian Department of Agriculture, attended the meetings of the New York State Fruit Growers' Association at Rochester, N. Y.

Mr. E. H. Strickland, Entomological Branch, Department of Agriculture, Ottawa, Canada, has recently visited the Museum of Comparative Zoölogy and the Bussey Institution of Harvard University where he spent six weeks studying mites under Dr. Banks.

Recent appointments in the Bureau of Entomology are announced as follows: Perez Simmons, pea and bean weevil investigations, Alhambra, Cal.; Earl R. Van Leeuwen; W. H. Carpenter; Curtis P. Clausen; A. L. Johnson, Alabama; J. C. Bridwell, Honolulu.

The following resignations are reported from the Bureau of Entomology: F. B. Milliken, to enter commercial work; H. H. Stage, to become entomologist of the St. Louis and Southwestern Railway Lines; Dr. Roger C. Smith, to accept a state position; George B. Fisher; Roger J. Chambers; A. P. Swallow, to enter commercial

work; E. R. Jones; E. G. Baldwin; H. A. Scullen; H. D. Smith; E. M. Searls T. D. Urbahns, to accept a position with the California State Department of Agriculture; A. B. Jarrell; H. D. Smith.

Mr. C. A. Reese has severed his connection with the State Department of Agriculture, Charleston, W. Va., as state apiarist to take charge of similar work for the Florida Plant Pest Board under Prof. Wilmon Newell. Mr. Reese took up his duties at Gainesville, Fla., March 1, 1920.

The following recent appointments in the Entomological Branch, Canadian Department of Agriculture, are announced: Mr. Ralph Hopping, Division of forest insects; Miss M. Nash, temporary clerk stenographer at headquarters; Miss J. R. Oliver, temporary clerk stenographer at Vineland Station Laboratory.

Resignations in the Entomological Branch, Canadian Department of Agriculture, are announced as follows: Mr. C. C. Rokeby, temporary superintendent of fumigation, Windsor; Mr. R. N. Chrystal, forest insects; Mr. E. A. McMahon, Annapolis Royal Laboratory, to accept a position with the John Cowan Chemical Company of Montreal.

Dr. J. H. McDunnough, officer in charge of the National Collection of Insects, Dominion of Canada, has been promoted to the position of chief of the Division of Systematic Entomology. On account of lack of space for the National Collection of Insects, tenders have been issued for ten new steel cabinets; these will hold 250 insect drawers.

In an endeavor to prevent the further spread of the apple sucker (*Psylla mali* Schmid) by artificial means, a quarantine has been placed on the infested district in the vicinity of Wolfville, N. S. No apple stock, including seedlings, scions, buds or grafts, may be removed from the quarantined area unless it is accompanied by a certificate of inspection.

Mr. Curtis P. Clausen, a graduate of the University of California, has been appointed by the Bureau of Entomology, specialist in insect parasites of the Japanese beetle, and will soon sail for Japan, where he will undertake a study of all natural enemies of this insect in that country, with the view of introducing the natural enemies of the beetle into New Jersey.

Mr. W. H. Goodwin, Bureau of Entomology, was to have entered upon the investigation of mill insects, December 1. Because of ill health he asked for a leave of nine months without pay. He has accepted employment with a commercial firm and, in view of his practical experience along the line of flour-mill insect control, it is probable that he will continue in commercial work.

The Bureau of Entomology Laboratory at Seaview, Wash., where investigations of cranberry insects have been made during the past two seasons in coöperation with the Washington Agricultural Experiment Station, has been discontinued, and H. K. Plank will be placed in charge of the Bureau's laboratory to be reëstablished in Michigan for the purpose of making investigations of deciduous fruit insects in that region.

A hearing was held in Washington, D. C., February 24, before the Federal Horticultural Board in relation to quarantine restrictions on account of the European corn borer. Among the entomologists present were: E. N. Cory, Maryland; J. G. Sanders, Pennsylvania; T. J. Headlee, New Jersey; W. E. Britton, Connecticut; W. C. O'Kane, New Hampshire; and Messrs. C. L. Marlatt, W. R. Walton, D. J. Caffrey, E. R. Sasscer and L. H. Worthley, Bureau of Entomology; Massachusetts was represented by Dr. A. W. Gilburt, commissioner of agriculture, and New York

State, by Mr. G. G. Atwood, chief of the Bureau of Plant Industry. The arguments were against quarantining states not known to be infested, and in favor of allowing shelled corn, vegetables, nursery and flower plants to move under a system of permits, inspection and certification. Quarantine 43 is the final outcome.

The following transfers are announced in the Entomological Branch, Canadian Department of Agriculture: Mr. P. N. Vroom, Fredericton Laboratory, temporarily to headquarters, Ottawa; Mr. A. E. Kelsall, Annapolis Laboratory, three months' leave of absence to study the chemistry of insecticides at McGill University; Miss Grace McCarron, Fredericton Laboratory, to clerk stenographer at headquarters, Ottawa.

Officers of the Brooklyn Entomological Society for 1920 are as follows: President, W. T. Davis; vice-president, J. R. de la Torre Bueno; treasurer, Rowland F. McElvare; recording and corresponding secretary, Dr. J. Bequaert; librarian, A. C. Weeks; curator, George Franck; Publication Committee, J. R. de la Torre Bueno, editor, George P. Englehardt, Dr. J. Bequaert; delegate to council of New York Academy of Sciences, Howard Notman.

Dr. R. R. Parker, assistant entomologist, Montana State Board of Entomology, in charge of tick eradication work in the Bitter Root Valley, Montana, who was to have sailed for Poland February 1 with an International Red Cross expedition to study typhus fever for a three months' period, has been delayed and the expedition has sailed without him. Dr. Parker first had influenza, and complications which have since arisen have made a surgical operation necessary.

Recent transfers in the Bureau of Entomology are as follows: Vernon A. Roberts (temporarily), to Orlando, Fla.; M. C. Lane, Berkeley, Cal., to Forest Grove, Ore.; B. G. Thompson, Forest Grove, Ore., to Berkeley, Cal.; A. H. Beyer, W. B. Cartwright, T. S. Wilson, R. J. Fiske, W. G. Bemis, H. B. Carpenter, W. L. Miles, temporarily to pink bollworm work; Thomas H. Jones, to Fort Myers, Fla.; C. M. Packard, Hagerstown, Md., to Cal., B. R. Leach, Dover, Del., to Riverton, N. J.; William A. Hoffman, Brownwood, Tex., to Riverton, N. J.

Mr. J. C. Bridwell, a graduate of the Iowa Agricultural College, has been appointed to the Bureau of Entomology as "specialist in Bruchidæ and their parasites," with headquarters at Honolulu. The increased plantings of the introduced algaroba tree throughout the Hawaiian Islands has led to the development, during the past ew years, of the manufacture of a valuable stock feed from the seed pods of this tree. Chemical analyses prove that the algaroba bean weevil (*Bruchus prosopis*), which was introduced into the islands along with its host plant, is responsible for a large loss in the protein content of the feed. Because of the equable climate and the ripening of successive crops of pods throughout the year, the infestation of the pods on the tree is heavy and probably will not yield to artificial control measures. Several parasites already present in Hawaii may be accomplishing all that parasites can in limiting the damage caused by the weevil.

Lord Walsingham (Thomas de Grey) of Merton Hall, England, died December 3, 1919. He was born July 29, 1843, and early became interested in the study of the Microlepidoptera in which for many years he has been considered one of the leading authorities of the world. His entomological activity covered more than half a century. He made a collecting trip to the Pacific coast of the United States in 1871–72, and was greatly interested in the insect fauna of America and described many new species. Among his many published papers are North American Tortricidæ, British Museum, 1879; Pterophoridæ of California and Oregon, London, 1880;

Some North American Tineidæ, 1881; North American Coleophoræ, Trans. Ent. Soc., London, 1882; Revision of the Genera *Acrolophus* Poey, and *Anaphora* Clem., Trans. Ent. Soc., London, 1887; Steps toward a Revision of Chambers' Index, with Notes and Descriptions of New Species, Insect Life, Vols. I–IV, 1888–92; The Microlepidoptera of Teneriffe, 1907; Bilogia Centrali Americani, Vol. IV.

The brown-tail moth work in New Brunswick was closed down in the middle of January. No nests have been found during the past two years. Only four men were employed this season, and the greater portion of the territory was scouted with the aid of a car. In Nova Scotia 267 brown-tail nests were collected up to January 31; this is a considerable reduction as compared with previous years. The brown-tail moth is still continuing to breed in this Province and local infestations are uncovered from time to time. The majority of scouts were discharged on January 31.

A new sweet-potato weevil district has been discovered in the state of Mississippi, embracing about fifteen infested properties east of Ocean Springs, along the line of the Southern Railway, probably caused by the shipment of sweet-potato plants from the infested section in Louisiana. It is worthy of note that the sweet-potato crop, according to statistics published in the December issue of the *Monthly Crop Reporter* of the Department of Agriculture, is greater in value by about $20,000,000 than that of last year. The six Gulf States, in which infestations of the sweet-potato weevil have been noted, produce more than 50 per cent of the crop for the United States.

Mr. Ralph Hopping, in charge of forest insect investigations in British Columbia for the Division of Forest Insects, is supervising control operations in the beetle-infested yellow pine of the Coldwater Valley and the adjoining district west of Merritt and Canford, B. C. The work is undertaken in coöperation with the Provincial Forest Branch of British Columbia, the Dominion Forest Branch and local lumber companies. The control methods include modified logging operations, the salvage of the timber when this is feasible, and the burning of the slash. Mr. Hopping is having excellent success in organizing this important work, and we entertain great hopes that a large body of fine timber will be saved thereby.

The annual meeting of the entomological workers in Ohio institutions was held at the Ohio State University, Columbus, Ohio, January 29, 1920. Morning, afternoon and evening sessions were held, and the following program was rendered: Symposium: The Function of My Department in the Work of the State, H. A. Gossard, entomologist, Experiment Station; Raymond C. Osburn, head, Department of Zoölogy and Entomology, Ohio State University; E. C. Cotton, chief, Bureau of Horticulture. Papers: Herbert Osborn, Notes on Leaf-Hoppers; H. E. Evans, The Effect of the Federal Plant Quarantine Act on the Nursery Business; W. M. Barrows, The Changes Which Take Place in Insect and Arachnid Muscle During Metamorphosis; T. L. Guyton, Results of the Use of Magnesium Arsenate as an Insecticide in 1919; W. H. Larrimer, La Fayette, Ind., Army Worm Control Through County Organization; L. L. Huber, Two Parasites of the Resplendent Shield Bearer; Annette F. Braun, The Study of Microlepidoptera; C. L. Metcalf, The Use of Insect Genitalia in Classification; W. C. Kraatz, Remarks on the Insect Fauna of Mirror Lake; C. H. Kennedy, Life Histories of the Dragon Flies; H. A. Gossard, The Relation of Bees to Fire Blight; E. L. Wickliff, Insect Food of Young Bass; H. L. Dozier, Observations on Some Florida Insects; R. S. McKay, Observations on Orthoptera in Southern Ohio in 1919; E. W. Long, Apiary Inspection in Relation to Entomology; W. V. Balduf, Soy Bean Insect Investigations. Round Table: The Hessian Fly in Ohio in 1919, T. H. Parks, leader. Papers: R. C. Osburn, Some Remarks on the Genus Syrphus; F. H. Crecker, Distribution of Fresh Water Sponges

by Caddis Fly Larvæ; J. S. Hine, Blood-Sucking Insects Observed on the Katmai Expedition; E. A. Hartley, Some Observations on Bark Beetle Depredations in Western Yellow Pine in Oregon; P. R. Lowry, Remarks on the Dactylopiinae of Ohio; J. S. Houser, The Onion Maggot. The following officers were elected: President, J. S. Houser; vice-president, H. J. Speaker; secretary, T. H. Parks.

A conference of entomologists was held at the Grand Central Terminal Building, New York City, on March 31, to consider standardizing formulas for dusting; contact insecticide dusts; the advisability of arranging experiments in different states to obtain more accurate information regarding dusting in comparison with spraying for the control of orchard insects. The following entomologists were present:—Dr. E. P. Felt, Albany; Professor P. J. Parrott, Geneva; Professors G. W. Herrick and C. R. Crosby, Ithaca, N. Y.; Dr. T. J. Headlee, New Brunswick, N. J.; Professor H. E. Hodgkiss, State College, and Mr. S. W. Frost, Arendtsville, Pa.; Dr. W. E. Britton, New Haven, Conn.; Dr. A. L. Quaintance, Bureau of Entomology, Washington, D. C.

The seventh annual meeting of the New Jersey Mosquito Extermination Association was held at the Chalfonte Hotel, Atlantic City, February 5 and 6. The first session was called to order at 8 p. m., Thursday, February 5, by the president of the association, Walter R. Hudson, with an address, "The New Jersey Mosquito Problem and Its Solution." This was followed by a paper by Dr. L. O. Howard, "Objects, Methods and Results of Mosquito Control in Different Parts of the World." The speaker gave probably the most complete résumé of the work and the published results that has been prepared and which will be of much value for reference when published in the proceedings of the association. The second session, Friday forenoon, was given up to a "Symposium of the 1919 Work of Mosquito Control and Its Results." Reports of the county commissioners from twelve counties were read, followed by a summary of the state and county work by Dr. T. J. Headlee. At the afternoon session reports were presented on the methods and results of mosquito work in Connecticut, Nassau County, New York, Pennsylvania, and New York City. The closing session at 8 p. m. was opened by an address, "Objects and Aims of the Mosquito Work of the Department of Conservation and Development," by Alfred Gaskill, director. The attendance was less than at some of the previous meetings due to the severe storm which started February 4, and continued during the two days of the meeting. Several important papers were omitted as the speakers were unable to make connections due to delayed traffic, but the time was fully taken up with interesting discussions which would have necessarily been omitted if the complete program had been carried out.

GIPSY MOTH CONFERENCE

On February 3, 1920, a meeting was held at the State House, Boston, Mass., to discuss the present status of the gipsy and brown tail moths in New England, also to exchange ideas and views concerning the work of suppression.

Among those present were:—M. H. McIntyre of Maine; Professor W. C. O'Kane, W. A. Osgood and Philip Ayers of New Hampshire; H. L. Bailey of Vermont; Harry Horovitz of Rhode Island; I. W. Davis of Connecticut; W. A. L. Bazeley, Commissioner of Conservation of Massachusetts, and members of the State Gipsy Moth and Forestry Departments; L. S. McLaine of the Dominion of Canada; Dr. L. O. Howard, Chief of the Bureau of Entomology; Mr. A. F. Burgess, in charge of the gipsy moth work in New England for the Bureau, and members of the field and laboratory force.

The morning session was given over to the discussion of the gipsy and brown tail moth situation in the several states by their representatives.

Several centralized infestations of the brown tail moth were reported, but it was thought that by proper treatment, these centers of infestation could be eradicated.

It was the consensus of opinion, however, that in order to cope with the gipsy moth in its now largest area ever infested, larger appropriations are imperative, not only on account of this increase of territory but also on account of the higher prices of equipment, supplies and labor.

The representatives of the various states realized the seriousness of the situation and emphasized the need of increased Federal appropriations because of the inability of their several states to furnish sufficient funds to carry on all the work that should be done. With this in view, the recommendation of Dr. L. O. Howard to have the appropriation increased $100,000, was heartily endorsed.

Mr. L. S. McLaine of Canada expressed his fears of the present spread of the gipsy moth, which is about 37 miles from the Canadian border, on account of the favorability of the territory to which it is spreading.

After luncheon at the City Club, through the courtesy of Mr. W. A. L. Bazeley, Commissioner of Conservation of Massachusetts, the afternoon session was given over to papers by the various members of the Federal Bureau on problems such as wind spread, non-hatch of gipsy moth egg clusters, cranberry bog investigations, quarantine, forest management, and the present status of the parasites.

The coöperation of the infested states with the Federal Bureau was manifested by the harmonious discussions of the various problems.

Mailed April 30, 1920